FLORIDA SEA GRANT COLLEGE

ARTIFICIAL REEFS IN FLORIDA

Edited by Donald Y. Aska

Report Number 24

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ARTIFICIAL REEFS IN FLORIDA

Proceedings of a conference
held June 10 and 11, 1977
at the Bayboro Campus,
University of South Florida
St. Petersburg, Florida

Coordinated by the
State University System of Florida
Florida Sea Grant College

in cooperation with

Coastal Plains Center for Marine Development Services
U.S. Corps of Engineers
Florida Department of Environmental Regulation
Florida Department of Natural Resources
National Marine Fisheries Service (NOAA)
St. Petersburg Junior College
University of South Florida

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FOREWORD

The value and productivity of natural fishing reefs have long been recognized by recreational and commercial fishermen and divers both in fresh and marine waters. Increased user pressure, combined with man's constant efforts to duplicate and enhance nature's bounties, has encouraged the construction of artificial reefs of varied substance, positioning and productivity in the coastal areas and inland waters. These efforts have catalyzed improved technology, stimulated ecological research, interested public administrators, fostered user association, and broadened public appreciation of the potential socio-economic benefits that can result. Hopefully, these efforts will be at no expense to, but rather increase, the natural ecological balance of these waters.

In response to needs expressed by numerous fishing, diving, research and public groups, the Florida Sea Grant College organized a Conference on Artificial Reefs in Florida. The objectives of the conference were to assess the state of the art, review socio-economic - biological impacts of reef construction, development and use, and identify areas where user-agency needs and services could better mesh.

The Conference had as its genesis an earlier, localized workshop, held in Sarasota, Florida, June 16, 1976, at which time local Sarasotoans met with federal and state agency and educational institution representatives to discuss permitting procedures, bio-socio-economic aspects of artificial reefs, as well as new engineering techniques. The interest therein stimulated, quickly spread throughout the state and the 1977 Conference was organized to respond to these needs.

This report is designed to summarize the two days of discussions and, hopefully, provide a distillation of the proceedings to persons unable to attend as well as to stimulate and catalyze further research and response action by persons, agencies, associations and institutions interested and concerned with the fascinating under-water world. The following abstracts of the presentations will give the reader an insight into experiences, concepts, and recommendations of experts in the various fields. Readers are urged to communicate directly with the program speakers for further details.

Donald Y. Aska, editor of this publication, is consultant to the director, Florida Sea Grant College, and former coordinator of the Florida Marine Advisory Program.

INTRODUCTION

Hugh L. Popenoe
Conference Chairman

The primary purpose of this conference is to sort out the more salient facts on the value of, and problems concerned with, artificial fishing reefs in Florida. Factors to be considered are the environmental, economic and social impacts of these underwater structures on local coastal communities to put the best of past experience to best future use.

The construction of artificial reefs in Florida has been one of almost exponential growth since World War II. Data available to us indicate that prior to WW II, there were only about 8 such reefs, if we consider only those constructed through approved regulatory agency processes. In contrast, there were about 226 constructed during the 1960's and 70's. Obviously, the tremendous increase in residential population in the state has been a significant factor. But probably equally contributive have been the increase in tourism attracted to Florida's extensive coastline, and the better public understanding of how reefs can and do work. This increased interest in marine recreation and the concommitant growth of coastal marinas and the charter boat, or "headboat," industry has brought near-shore and off-shore recreational fishing opportunities to those persons normally restricted to land attached platforms.

As a result, there has been a growing interest on the part of local communities and organized sports fishing groups as to how they should go about establishing artificial reefs or, conversely, whether they should even get involved in this type of enterprise. Fisheries experts throughout this and other countries have researched many of the basic ecological dynamics. It is generally agreed that reefs, properly located and structured, stimulate the biomass. However, there are other considerations and one, the bottom line determination of the socio-economic return, is still indefinite.

Reefs are costly; does it really pay for a community to install and support them? There are many problems with permitting procedures that local officials and private groups find difficult to handle. We hope, during the course of this conference, to troubleshoot some of the needs in this area; perhaps facilitating

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development of more manageable permanent guidelines, and perhaps the development of a handbook which will guide local officials and groups when they do intend to install artificial reefs. We also hope to see if we can identify some other priority problem areas in the whole question of artificial reefs; whether, for instance, we in Florida Sea Grant need to develop a task force or advisory effort that would go to local communities and help them make plans and necessary decisions. Are the available reefs known to resident and tourist fishermen? Are there innovative engineering techniques that can be more generally used? What is the role of the artificial reef in the overall fisheries management spectrum?

The planning for this conference started last June at which time the Florida Sea Grant Program, through its Marine Advisory Program, sponsored a small meeting in Sarasota, Florida, on artificial reefs. Requests for similar local meetings soon developed throughout the state. We decided the most practical response was to sponsor a statewide meeting whereby we could assemble interests and expertise at one central point to obtain a more comprehensive overview of the state's interests, problems and needs.

This conference represents Florida Sea Grant's first public thrust to come to grips with an area of marine recreation in which there has long been an expressed group need. Previously we have been involved mainly in coastal engineering, commercial fisheries, estuarine quality, and marine educational programs. We have recognized the importance of marine recreation but wrestled with the difficult problem of "where does one start?" Do you start with the local planners, the mariners, the sportfishing fleet, the beachgoers, or the recreational divers? Therefore, we decided to begin with artificial reefs since the needs and interests have been expressed and since response to our preliminary proposal was so encouraging.

In organizing the agenda we have tried to incorporate as many points of view as reasonable conference time permits. Groups exist that are not convinced that artificial reefs are environmentally sound. Time has been provided for such points-of-view. Our task at Florida Sea Grant is not to advocate one position or another - - whether we should or should not have artificial reefs, or how they should be constructed or administered - - but rather to serve as a catalyst for ideas, innovations, and accounts of actual experience - not just by professionals or academicians, but by all groups - to try to bring all of these opinions together and then when the normal political process does take place it is an informed process - that it does have the facts available on which to base informed decisions so that the advantages and disadvantages can be put into proper perspective by the involved constituencies.

We will be talking about planning artificial reefs, about permitting problems, siting problems, engineering aspects, the

biological effectiveness of certain types of reefs, reefs as management tools, and also, very importantly, how these can be administered and what are the socio-economic ramifications.

The goals of the conference, then, are to cultivate better interaction among the groups involved in reefs, and to foster a better understanding by the planners, constructors, administrators and users of artificial reefs, on the engineering aspects, and the siting problems. Furthermore, we hope there will develop a better understanding by the various local, state and federal agencies involved in the permitting processes. In this latter regard we hope to generate better coordination between applicant and regulator so that they may work in harmony, that some provision can be developed whereby reefs are not taken on a case by case basis and that some long-term permitting procedures can be developed. An important goal is the development of a methodology whereby the optimum socio-economic returns of various types of reefs may be determined.

Another goal is to explore the need for a statewide atlas of artificial reefs. While we already have considerable data made available by the various permitting agencies, these are probably not complete in all details - accurate siting, physical dimensions, composition, species composition, depth, seasonal productivity and navigational markings. Such an atlas could be periodically updated.

Finally, we will be publishing the results of this conference in the form of "Proceedings." We hope it will provide useful information to all groups engaged in, or considering entry into, this important marine activity.

This conference was developed, under the leadership of Donald Y. Aska, by a steering committee comprised of representatives of the Florida Department of Natural Resources, Florida Department of Environmental Regulation, U.S. Corps of Engineers, National Marine Fisheries Service, University of South Florida, St. Petersburg Junior College, Pinellas County government, and the Florida Sea Grant Program. Grateful credit is given to them as well as to the individual session chairmen who volunteered their time and experience. We also appreciate the splendid cooperation of the speakers, their sponsoring agencies or groups, and the wide geographical audience and its participation. Without those components this conference would not be a fact. The fine conference facilities, and support staff of our host, the University of South Florida, have certainly contributed to the conduct of the conference and are gratefully acknowledged.

A NATIONAL OVERVIEW

Richard Stone

History is a tangible yardstick for measuring progress in the artificial reef programs throughout the country and provides us with experience that can enable all of us to benefit from past mistakes and successes. It has been demonstrated, to our satisfaction, that such reefs, properly sited, contructed and maintained, are a boon to marine recreation. We can also state that failure to meet these planning requirements can lead to disappointing results and adverse sponsor, and user, reaction.

Some of the problems are obvious: fragmentation of effort; inadequate budgeting; complex permitting procedures; inadequate preconstruction site surveys; improper maintenance; and unrealistic expectations.

Essentially, artificial reefs differ from natural reefs only in the fact that they are man-made. They have the advantage of being site specific, a fact that is particularly attractive to Florida and several of the other Southeastern areas where reef fish populations can be increased providing the lack of natural rock or other rough bottom formations can be overcome.

Our research reveals that records of reef construction in the United States extend as far back as the 1800's when South Carolina settlers began to clear the Barrier Reefs of trees to plant cotton. The felled trees, in turn, provided marine sanctuaries for local species. However, as these trees disappeared, the settlers had to resort to building wooden structures to take the place of this vanishing habitat. New York also has an early history of reef construction as did California and Hawaii. The Gulf States, Alabama, Florida, and Taxas, also have been involved for many years.

Intensive Federal involvement in this field was initiated by the U.S. Bureau of Sport Fisheries and Wildlife at its Sandy Hook Marine Laboratory, Highlands, New Jersey, in 1966. The original project objectives were to survey and assess past reef construction projects to determine relative efficacy, evaluate various building materials, project optimum sites, develop

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recommended engineering techniques, assess biomass impact, and evaluate reefs as an effective fishery management tool. This involved close cooperation with both State and Federal agencies as well as local, public, and private groups.

The principal program thrust was in the Southeast where relatively warm, clear waters facilitated underwater observations throughout the year. Biologists employed various techniques such as trapping, tagging, releasing, and direct observations of population succession on the new reefs. Migration, seasonality, fecundity, growth rate, habitat perference, food habits, and predation patterns were monitored when possible.

Numerous reef building materials were tried. Auto bodies were particularly abundant in the New York - New Jersey area. However, costs of cleaning and transporting them proved impractical and over time they showed a rapid deterioration rate. Concrete rubble has a long life and is generally readily available. Ship hulls make an excellent reef nucleus as they provide a high profile and stability, good concealment, and invertebrate growth. Tires are plentiful, cheap, reasonably easy to handle, process, and transport to the dumping site. The weight/surface ratio is extremely favorable. The local situation largely determines the most satisfactory material.

Earlier efforts to determine the feasability of artificial reefs as management tools were not productive in the northern waters but did prove more successful in the southern waters, particularly in Florida. An artificial reef, using tires, was initially constructed adjacent to a natural reef off Elliott Key, Florida and a continuous survey of the two reefs was conducted over a $2\frac{1}{2}$-year period. The reefs were small enough to enable complete individual and species counts, with duplicate counts being made over a 2-3 day period.

After the $2\frac{1}{2}$-year study, the artificial reef was then completely encircled by a net and poisoned to provide a total population count. A team of 28 divers and 7 vessels completed the operation in a 12-hour marathon. Not only were the fish collected but each tire also was brought up, a requirement since the reef had been placed within the jurisdictional waters of the Biscyne National Monument. This exact fish count enabled confirmation of the reliability of periodic underwater surveys.

Several interesting facts evolved from this experiment. From February 8, 1972, until conclusion, the invertebrate growth on the artificial reef fluctuated, but showed a steady growth throughout the study. A rapid increase of fish species and individuals occurred, mostly in the form of juveniles, between construction and August 1972. By August, both reefs supported nearly equal vertebrate populations and, at that stage, the

artificial reef was determined to have reached its carrying capacity. Both test reefs thereafter fluctuated seasonally in about the same manner with little difference in species number and composition. There was, in effect, a doubling of the biomass in the area.

Some general conclusions can be drawn: Artificial reefs do not differ substantially in biomass from natural reefs of similar size and structure in comparable waters. They can effectively improve rough bottom habitat, can add to total fish biomass, and can provide a functional management tool for reef fish resources. They have potential as nursery areas, as commercial and recreational fishing grounds in more accessible areas, and can be constructed with a wide variety of materials.

There are vexing problems involved, the primary one being the lack of communication between people involved in building reefs. Mistakes are repeated; the wheel is constantly being reinvented. Conferences of this type are a very helpful tool in resolving or reducing this problem. State, Federal, and local permitting procedures frequently inhibit or totally discourage promising reef construction. The fact that this is being recognized by many of the regulatory agencies, and remedied, is encouraging. Florida is to be complimented on its action in this regard. Better data collection methods are needed to evaluate future uses, reef size, and productivity. Management improvements are needed and perhaps the Fishery Conservation and Management Act of 1976 will help develop the concept of using artificial reefs to increase biomass where there is an absence of rough bottom. The end product, enhancement of ecological and aesthetic productivity, certainly justifies the efforts of the public and private agencies and individuals involved in artificial reef research and construction.

FIRST TECHNICAL SESSION
John E. Greenfield, Chairman[1]
Donald E. Sweat, Moderator[2]

ARTIFICIAL REEF SITE SELECTION

Heyward Mathews[3]

Unfortunately, many artificial reefs in the past were built by well-intentioned but ill-advised fishing groups who simply picked a spot on a chart and said, "Let's build it here". The site was often on a shifting or soft bottom and many thousands of dollars and countless man-hours of labor were subsequently lost when the reef disappeared or ceased to serve as fish habitat.

The scientific community was in part to blame for these early failures by not providing a sound data base on this subject from which the fishermen could seek help. Until the late 1950's almost no research had been published on artificial reefs in this country, and what little had been done elsewhere was in Japanese. Even today we still suffer from a lack of adequate research on many important aspects of artificial reef dynamics and economics.

The location of a reef site can be one of the most important decisions of the whole project. The choice of the distance off-shore for a reef site involves a conflict between large fish with greater depth vs. decreasing accessibility to small boats. Up to a point, greater depth will attract large species of predaceous fish like king mackerel, cobia, and amberjacks. But when the reef is far out of sight of land, it not only becomes hard for small boats to find but also increases the risk that a small boat will be too far off-shore to seek safety during squalls and thunderstorms.

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[2] Mr. Donald Sweat is Marine Extension Agent, Florida Cooperative Extension Service, Largo, Florida.

[3] Dr. Heyward Mathews is Professor of Biology, St. Petersburg Junior College, Clearwater, Florida.

The depth of water for the reef site must also take into consideration the type of material to be dropped. If only "low profile" materials are to be used, like compacted tires or small-size building rubble, then a depth of 20 or 25 feet for a reef would be adequate in areas where the greater depths are not available, such as an estuary. If, however, reef materials are to include large diameter culverts or bridge rubble, even greater depths will be needed to maintain adequate clearance over the top of the reef. If barges or ships are to be used as reef materials, then still greater depths are needed.

Consideration should also be given to the navigation of small boats likely to frequent the reefs. In most areas the fisherman will be leaving through a common channel, pass or municipal marina. Most small boats do not have expensive compasses, so a heading at 317^{o} or 112^{o} would be much harder to run than a due west, or something like southwest. In most instances the type of bottom needed for a reef is so abundant that the initial location can be done by drawing a southwest (or western) line from the sea buoy and going out this line until the proper depth and bottom type are located. Usually a due east, west, or south heading is the easiest to run and to remember by a small boat fisherman, but this may often conflict with a shipping lane.

Reefs should never be located in or adjacent to a shipping lane. Not only do their unlighted buoys create a hazard for shipping, but the risk of a large ship running over a small boat in the dark increases. Shipping interests, however, should recognize that the ocean belongs to all users and they enjoy no special "ownership" of the high seas. International rules of the road give the right-of-way to fishing vessels over other motorized craft.

Once the general area has been selected, diver(s), preferably diver/biologist must locate the best type of bottom substrate for reef location. The first thought is often to find a solid rocky bottom so the materials will not sink into the sand. However, a rocky bottom normally will already have a well established natural reef community, and the dropping of reef materials on top of it will destroy coral, sponges, and other established reef organisms. It is preferable to select another nearby site that does not risk damaging an existing producing community. For the same reasons, reefs should not be located on submerged grass beds. These are already productive and should not be damaged or altered by reef materials.

Soft-fine grained sediments composed of silt and clay size particles make poor reef sites because often 50 to 75% of the reef materials will sink down into the mud and be lost as habitat. Shifting sand in areas where tidal currents are constantly moving sand are also best avoided, as again much of the reefs effectiveness can be lost as the materials are buried. This has happened often in the past to reefs built too close to shore where sand is moving up and down the coast line.

The best reef-building bottoms are hard-packed sand or pebble size sediments. Often sites can be found with a sand overlay on a rock foundation, which is ideal since the underlying rock will prevent any significant sinking of heavy reef materials.

The depth of the site is important not only because of its influence on larger fish, but also because of its importance to benthic algae. When reefs are built in the photic zone they provide substrate for algae. This results in reefs actually becoming autotrophic or food procucing. In the past, artificial reefs were considered to provide only habitat and therefore mainly act as "concentrators of existing fish populations". In studies conducted in the early 60's, artificial reefs were shown to be capable of primary production levels comparable to some grass and coral reef communities. (Mathews, 1966 unpublished Master's Thesis).

This means an artificial reef, when built in depths above the compensation depth, will actually increase the basic food production at the base of the food chain. Artificial reefs then become not only a benefit to fishermen and divers, but increase marine productivity in the area. Very few of man's coastal activities can make a similar claim.

Another vital consideration is the depth in relation to wave energy. In high energy coastlines the reef must be deep enough to avoid heavy wave action. Most reef building materials cannot withstand heavy wave action, and those that can, are often shifted or displaced by wave action. This means that most exposed areas with depths of less than 25 feet in the Gulf and 40 feet in the Atlantic are undesirable.

Areas subject to strong currents are also less desirable, both because of the problems to boats anchored trying to make a line sink, and due to the ability of a bottom current to scower out under reef materials or sand bottoms and thereby work them down into the bottom.

<u>The following recommendations are submitted</u>:

The site selection should always be made <u>after</u> the type of reef material is chosen.

As a general rule, the highest possible profile should be achieved with the available materials.

High profile reefs are going to attract not only the bottom species like grouper, sea bass, and snapper, but also pelagic forms like Spanish mackerel, cobia, and amberjack.

Larger profile materials, however, do require greater depths to prevent navigation hazards.

Steel ships and barges are ideal for reefs, because of their high profile. Split tires and culverts can also be bundled and dropped in such a way as to produce 6 to 10 feet of profile. Compacted tires however are less desirable because even they may be put into a high profile pattern when originally set they can unpile after a few months. Thesefore the final configuration is often not controllable.

Adequate time spent in the planning stages of a reef building project will pay off by insuring that the reef will provide the maximum benefit for the cost and labor expended.

FISH ATTRACTORS IN FLORIDA'S FRESHWATER LAKES

Jon Buntz

Submerged trees and brush piles have traditionally been known and used as fish attractors in freshwater lakes, ponds and rivers. During the 60's, tires were used experimentally, but, while evidently effective, they were never truly evaluated.

A research project was initiated in the 70's in which clay pipes, tires, concrete rubble, PVC, brush, and even hay, were used. As a check for effectiveness, some decoy buoy markers with signs, "Fish Attractors", were set over nothing except water. These later proved a certain point in that it took fishermen only a short time to find they could not get desired fish catches. They did, however, identify the legitimate attractor areas and caught more fish.

Efforts by the Florida Game and Fresh Water Commission have increased, especially in eutrophic areas where aquatic vegetation has been destroyed naturally or because of dredge and fill activities. Even such materials as hay and soybeans have proven effective in these eutrophic areas.

A device developed in Tennessee and called, "stake attractors", has been used with some success, but the materials are expensive, and installation is time consuming.

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While none of the attractors used have a life expectancy of more than two or three years, they have almost immediate results; sometimes in only two or three days fish begin to congregate around and among them.

Site selection is a concern, since there is competition for space (with water skiers and boat racers) and, of course, navigational restrictions. A minimum of three or four feet of open water must be atop the structure. Replacement of material due to siltation is also a constant problem.

Because of the successes to date, the Florida Game and Fresh Water Fish Commission plans to construct approximately 150 attractors over the next five years with placement on a statewide basis. These will be predominately brush and tire structures and will encompass about one-quarter acre each. This is an approved Dingell-Johnson project, designed specifically to enhance Florida's freshwater fishing success.

CARTOGRAPHY FOR ARTIFICIAL REEFS WITHIN SIGHT OF LAND

Andrew M. Nicholson[1] and Bill Burchfield[2]

Navigation charts are presently being developed for the Pinellas County Artificial Reef Program to fill two basic needs. First, the charts facilitate construction planning and record keeping. Second, the charts provide easy navigation for the general public in usage of the constructed reefs. This paper describes the mathematical principals and methodology used in preparing the charts for reefs withing sight of landmarks.

In navigation, a single observation provides information on a line of position. A line of position is a line on the earth's surface upon which the observer sits - somewhere. To fix the position, a second observation is required to provide a second line of position. The observer's position is fixed at the intersection of the two lines of position determined by the observations.

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2 Mr. Burchfield, USCG (Ret.) is Harbormaster, City of Clearwater.

Our objective was to develop charts showing lines of position determined from sextant observations of landmarks. The sextant was selected as the basic instrument for our charts as it has the advantages of simplicity, speed, accuracy and universal acceptance in marine navigation. As all reefs in the Pinellas County Program are within sight of land, sextant shots of horizontal angles between landmarks are the observations for determining the observer's lines of position, or fix.

The charts show the lines of position for angles left and the lines of position for angles right. The observers fix is at the intersection of one angle left line of position and one angle right line position.

Each angle left (or right) provides a line of position as a consequence of the geometric proposition the angle at any point, A, on a circle between two chords to points B and C, on the same circle, is equal to 1/2 the central angle between the radials to the same points B and C.

Surveyors will recognize the intersection of the two lines of position is an application of the resection (three-point) problem. The procedures used in preparing the charts are basically surveyor calculations. The narrative on chart construction which follows is written in the language of the surveyor. Your surveying department should be consulted for assistance in constructing your particular charts.

In selecting the targets for your chart, two pitfalls must be avoided. First, for greater accuracy from the sextant, angles left or right should exceed 17°. Second, no position on the chart should lie on a circle passing through all three targets. This condition creates an indeterminant position due to infinite solutions. Beyond these limits, targets are selected for visibility and distinction.

Preliminary information for constructing the charts includes the co-ordinates of the reef locations and the targets. Co-ordinates usually provided for these reefs and targets are geographic (latitude and longitude). Calculations are made on State-plane (Northings and Eastings) co-ordinates. Thus, co-ordinate conversions by Transverse Mercator or Lambert projection, as appropiate for your area, is required.

Each line of position is an arc of a large radius circle which passes through the chart area. Only lines of position for angles left or right at 10' minute increments are shown on the chart. These increments provide ease in plotting observations to the nearest minute.

Constructing the chart requires repetition of determining the limits of each line of position at the edges of the chart area. Once the limits are determined, the lines of position are drawn as arcs (computer graphics) or, with minor error, as straight lines (conventional drafting).

To start the project, the proposed reef is plotted on the NOAA chart covering the area. Several potential targets are selected from this chart. By trial and error plotting of angles left and right to these targets, angles greater than 17^{o} are assured. An arc is fitted through all three potential targets and the radial point determined. The arc is then carried to the reef side of the radial point to insure it misses the chart area.

Once the pitfalls are avoided, a trip to the reef area is made to verify target visibility. If possible, five or six potential targets should be selected for a final choice of three based on this field trip.

Once the final three targets are selected, the field geographic co-ordinates are obtained from your County Surveyor or NOAA (National Oceanic and Atmospheric Administration). These positions should be listed to three decimal places of a second or arc in latitude and longitude. Minor errors in location of the targets cause major errors in location of the chart. (A second of arc of latitude is approximately 100 ft and longitude is approximately 30 ft in Pinellas County, thus three decimal places is location to the nearest one-tenth foot). All geographic co-ordinates are then converted to State-plane co-ordinates for calculations.

Next the chart scale is selected based on the reef dimensions and proposed chart size. Ideally, the chart should cover an area beyond the reef on all four sides. Using the chart scale and reef co-ordinates, the co-ordinates of the four chart corners are calculated.

By inversing the chart corner co-ordinates with the target co-ordinates, the bearings between are determined. Angles left and right at each corner are found as the angles between these bearings. Comparing all angles left at the corners yields the range of angles left for the chart. Similarly, the range of angles right for the chart is found. The largest angle should occur at the corner closest to the two appropriate targets and the smallest angle at the farthest corner.

Given the range of angles left and right, the work involves repetition of finding the limits of each 10' minute increment line of position at the edges of the chart.

The first line of position determined is for the angle right or left to the nearest ten minutes just smaller than the largest angle right or left in the chart area.

The line of position is an arc segment of a circle. The center of the circle is found by a bearing-bearing intersection. The intersecting bearings are determined by deflecting the bearing between the two targets through an angle towards the reef area equal to 1/2 of 180^{o} minus twice the line of position angle. The radius of the arc segment is determined by inverse between the co-ordinates of the circle center and either of the targets.

The limits of the line of position on the chart are computed by bearing-distance intersections using the radial distance from the circle center and the chart edge bearings from the nearest corner. Each line of position has two limits. Each limit is located on the edge of the chart.

This process is repeated for each line of position, at ten minute increments through the range of angles left and angles right.

The limits of each line of position are then plotted along the chart edges and the lines of position are constructed between.

Once all lines of position are plotted, the chart is completed by plotting the reef, placing a properly oriented compass rose and labeling all points or lines.

A proposed reef off Dunedin served as a working example of the procedures described.

ARTIFICIAL REEF PERMITTING PROCEDURES IN FLORIDA

Mark Latch

The Florida Department of Environmental Regulations has statuatory jurisdiction for the issuance of artificial reef construction permits within the territorial waters of the State of Florida. These waters extend three miles seaward on the Atlantic Coast and three Spanish leagues or approximately ten miles, on the Gulf. This authority extends also to coastal bays and estuaries. Prior to July 1, 1975, this responsibility rested with the Board of Trustees of the Internal Improvement Trust Fund but that agency relinquished the permitting authority during the reorganization of the States governmental structure of that year. However, the BTIITF still retains the management and enforcement responsibilities. By state law, the DNR still retains review responsibility of all applications and DER action, pro or con, is not taken without considering DNR'S recommendation. (Ed. note: DNR refers to Florida Department of Natural Resources)

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As of June 1977, the Tallahassee office of DER has been the permit processing and issuing center. Administrative action is imminent to transfer this authority to the DER district offices. Simultaneously, action is being taken to standardize procedures for permit issuance to expedite the processing.

By screen projection, a DER permit application was reviewed and the type and detail of information explained. The first instruction states that the land owner in each case is the state of Florida. Essential to the processing of the application is the need for complete information on the following: local program or individual applying for permit with complete address and telephone; local country, section or township identification; intent of reef; type of material, quantity (if practical) and means of transport and deposit; exact navigational coordinates of proposed reef (preferably Loran C reading for optimum accuracy); approximate distance from nearest adjacent land; and method of reef material fixation (this point was stressed when using tires due to their instability unless properly secured). The former filing fee of $200 is being adjusted downward to $20 during the reorganization process.

Supplementary information that should accompany the application, is the nature and type of bottom material and the type of marking (if buoys, the type and method and frequency of maintainance). A cut-out from the appropriate National Ocean Survey (or Coast and Geodedic Survey) navigation chart showed location of proposed reef is desirable.

The problem of processing delay is acknowledged. The statuatory time limit is 30 days for DER to review and solicit outside review or request further information from applicant. From time of completed application DER reserves right for 60 additional days to issue a consent letter. This informs any objectors to the reef that a denial hearing request may be entered.

If no intent letter is sent, DER has 90 days from the time of completed application to issue, or else default permit becomes automatic.

A major objective of the decentralization program is to reduce application processing time. The goal is to ultimately reduce the 90 day limit to 30-45 days.

DER permits issued are valid for three years from the date of all state, and federal permit approval notices.

CORPS OF ENGINEERS - ARTIFICIAL REEF PERMITTING PROCEDURES

John Adams

Authority for Corps of Engineers permitting action stems from Section 10 of the River and Harbor Act of 1899, which conveys to the Corps authority for any structure in the navigable waters of the United States. Additional authority is provided under Section 404 of the Federal Water Pollution and Control Act, as amended, 1972. This jurisdiction, for artificial reefs, extends three miles seaward under the FWPC Act but extend to all US jurisdictional waters under the Rivers and Harbors Act. The FWPC Act does, however, contain environmental requirements not contained in the R & H Act.

The Corps and the Florida Department of Environmental Regulation are in the process of exploring a joint permitting process. This would involve a common application acceptable by both agencies in an effort to reduce the applicants paper work. The two agencies also plan to issue a joint informational pamphlet, explaining requirements of both, to assist the applicant. Probable effective date is September, 1977. The applicant would file in duplicate, one to the Corps and the other to DER. The Corp will publish its green sheet for public notice which would represent a joint notice with DER. A 30 day period for green sheet distribution is required by federal statute.

The Corps normally require 90 days for permit issuance providing there are no public objections. If public hearings are involved the time is necessarily extended. Even considering the joint procedure arrangement a 90 day period should be anticipated by any applicant, or more if public hearings are involved.

The information required on the application is essentially the same as that for the DER application form except that the Corps, at its discretion, may mandate the type of buoy markers to be used and the type and frequency of maintenance.

The Corp is particularly scrutinous of any proposed reef sitings in channels, major fairways, or waters bearing frequent or particularly commercial activity. Further, a 50 foot clearance is a fairly firm criterion, depending upon the controlling depth in the area and navigational considerations.

In its overall public interest review the Corp solicits review from the US Navy, Coast Guard, National Marine Fisheries Service, Sport Fisheries and Wildlife Service, Environmental Protection Agency and appropriate state agencies. It also reserves the right to observe the dumping operations as well as to require annual status reports in certain instances.

Permit duration is generally for three years with a six month construction extension if justified. If maintainance replinishment is required or requested the Corps has the option of granting a 10 year maintainance permit.

Mr. John Adams is Chief, Regulatory Branch, U.S. Corps of Engineers, Jacksonville, Florida.

No fee is required at time of filing. If the reef is to be used as a commercial venture the fee, upon permit issuances is $100. If strictly for recreational use the fee is $10. There is no fee for a permit issued to a federal, state or local government applicant.

Publications explaining Corps permitting regulations and procedures are available from the District Engineer Office's throughout the country.

EPA'S ROLE IN PERMITTING ARTIFICIAL REEFS IN OCEAN WATERS

Reginald G. Rogers

The Environmental Protection Agency (EPA) involvement in permitting of artificial reefs originated with the Marine Protection, Research, and Sanctuaries Act of 1972, (MPRSA). Under regulations promulgated from this Act, the Agency (1) issues a general permit for the transportation and disposal of vessels at sea, and (2) fishing resource projects are excluded from the Act. An example of a fishery resource project is the placement of oyster shells for the purpose of developing, maintaining, or harvesting of managed oysters. EPA is interpreting fishery resources to include artificial reefs.

A fishery resource project must be a State or Federally authorized program and certified to EPA by the agency authorized to enforce the regulation, or to administer the program. Although no permit is required, the EPA reviews proposals for fishery resource projects and letters of concurrence must be obtained for these programs from the National Oceanic and Atmospheric Administration, the U.S. Coast Guard and the Corps of Engineers (COE). Also any government body wishing to place an artificial reef in the ocean must have a COE permit as discussed previously by Mr. Adams, (Corps of Engineers) and these same agencies, as well as other designated state and federal agencies, review the COE permit application. Therefore, a permit application to the COE serves the purpose for both the EPA and the COE. The private sector, such as a fishing club, that wishes to establish an artificial reef

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Mr. Rogers is Ecologist, Ecological Review Branch, Enforcement Division, Environmental Protection Agency, Region IV, Atlanta, Georgia.

would apply for a permit to the COE and EPA's involvement would be as a reviewing agency.

It was stated above that a general permit exists for the transportation and disposal of vessels in ocean waters. Details of that procedure include stating general information to the EPA about the vessel and the proposed disposal site and the assurance that appropriate measures have been taken to remove to the maximum extent practicable all materials that may create debris or degrade the marine environment. Other details regarding these procedures are found in the Federal Register dated January 11, 1977. Although disposal of these vessels must be at least 12 miles offshore and in 300 feet of water, they could nevertheless be classified as artificial reefs. In the past some vessels have been disposed of beyond the 12 mile limit in deep water, and thus out of reach of most divers. These could have just as easily been disposed of inshore in waters shallow enough for diving and fishing, and also provide safe navigation. It is a poor use of resources not to utilize these vessels as reef material.

Previous discussion has only referred to materials that are acceptable as reef material. There are also situations where a permit is violated and/or unacceptable material is dumped on the artificial reef. Now the picture is less clear and the legal minds begin to work. Whereas the Federal Water Pollution Control Act (FWPCA) prohibits dumping in cases of uncertainty (limited knowledge of a pollutant and its effects), the MPRSA leaves this as a judgment question for EPA and the COE. In reviewing and evaluating ocean dumping permit applications for materials other than hulks, and reef materials, the EPA Administrator shall consider the following criteria:

(a) The need for the proposed dumping;
(b) The effect of such dumping on human health and welfare, including economic, aesthetic, and recreational values;
(c) The effect of such dumping on fisheries resources, plankton, fish, shellfish, wildlife, shore lines and beaches;
(d) The effect of such dumping on marine ecosystems, particularly with respect to:
    (1) The transfer, concentration, and dispersion of such material and its byproducts through biological, physical, and chemical processes;
    (2) Potential changes in marine ecosystem diversity, productivity, and stability; and
    (3) Species and community population dynamics.
(e) The persistence and permanence of the effects of the dumping;
(f) The effects of dumping particular volumes and concentrations of such materials;
(g) Appropriate locations and methods of disposal or recycling, including land-based alternatives and the probable impact or requiring use of such alternate locations or methods upon considerations affecting the public interest;

(h) The effect on alternate uses of oceans, such as scientific study, fishing, and other living resources exploitation, and non-living resource exploitation;
(i) In designating recommended sites, the Administrator shall utilize wherever feasible, locations beyond the edge of the Continental Shelf.

The only fine that has been imposed by EPA in Region IV (and probably throughout the USA) involved Sec. 102, Sec. 103, and Sec. 101 of the MPRSA. This case was the M/V WITSHOAL II which dumped planks and wooden pallets off the St. Lucie Inlet. The out-of-court settlement with EPA was $1,000.00.

Other examples were cited wherein violations had occurred but due to mitigating circumstances it was administratively determined the violations were not willful and penalty action was waived.

And finally, I have two suggestions regarding positive steps that could result from this conference.

(1) Maximum effort be made to persuade those desiring to dispose of vessels to place them on authorized artificial reef systems.

(2) The State develop a program of certification for county, city, and private groups that would enable all to be excluded from the EPA permit under the MPRSA.

U.S. COAST GUARD - ARTIFICIAL REEF PERMITTING PROCEDURES

Janice Page

The principal concern of the Coast Guard is adequate marking of an artificial reef. Coast Guard concurrence is required prior to issuance of any permit.

Emphasis has been placed on those instances where a vessel is to be sunk to form the artificial reef. Prior to sinking the vessel, it must be inspected by the local Coast Guard to insure that the craft to be sunk is sufficiently seaworthy to reach its destination, and that there is no oil aboard to pollute the waters. The Coast Guard also reserves the right to have a Coast Guard escort, or ship rider, to insure prescribed delivery to the approved site.

Lt. (jg) Page is with the Maritime Environmental Protection Branch, Seventh Coast Guard District, Miami, Florida.

INTERVIEWS WITH ARTIFICIAL REEF USERS

Donald M. Schug

This information was collected in the past year as part of a Florida Sea Grant supported study of the Pinellas County Artificial Reef Project. Club meetings of local fishing and diving groups were attended and the project was discussed with the members who were asked questions concerning the popularity and success of the artificial reefs and invited to make suggestions on how the reef program could be improved. Opinions were also elicited from local dive and bait shop owners and charter and party boat captains.

The statements recorded during these conversations were often contradictory due to the controversial nature of the subjects discussed. Some of the opinions and suggestions expressed were unreasonable and obviously self-serving, but overall a good deal of objective and useful information can be gathered from this type of interview process.

Most of the anglers interviewed believe that artificial reef construction is an effective method of improving the local sports fishery which has been steadily declining due to environmental damage and intense fishing pressure. The artificial reefs are considered to be productive fishing sites, particularly during the seasonal Spanish and king mackerel runs. These runs generally occur during the spring and fall and coincide with the peaks in sports fishing activity. During the past year, however, the mackerel have not appeared in their usual large quantities. Many sports fishermen contend that this is due to both inclement weather and to commercial purse seining and gill netting which have allegedly reduced the population of bait fish serving to attract the mackerel to inshore areas. The anglers hope that artificial reefs can help alleviate the latter problem by providing the bait fish with additional habitats and thereby increasing their numbers.

Several anglers commented that the artificial reefs close to shore are located in water too shallow to attract large bottom fish such as grouper and snapper. Reefs constructed in depths greater than 60 feet would be more effective especially during the summer months when fish avoid the high shallow water temperatures. Constructing the reefs 15 to 20 miles offshore would not impair the accessibility of the reefs to experienced small boat operators. Those reefs 3 to 5 miles offshore in about 30 feet of water benefit, in general, novice fishermen and boat owners who fish only occasionally. These individuals prefer the convenience and security of fishing near shore.

Mr. Schug is a graduate student in Marine Science at the University of South Florida, Bayboro campus, St. Petersburg, Florida.

Many anglers feel that artificial reefs are not capable of sustaining continuous heavy fishing pressure and it was recommended that the buoys marking the reefs be removed periodically to allow the standing crop of sports fish to recover.[1] It was also suggested that a relatively inexpensive method of distributing the fishing pressure would be to buoy natural reefs and ledges, a practice that is quite popular in certain areas of Florida's East Coast.

A common criticism of the Pinellas County Project concerns the lack of publicity informing residents and tourists of the locations and advantages of the artificial reefs. Literature should be made available for inexperienced anglers describing the proper bait and rigging to be used while fishing over the reefs.

Artificial reefs are particularly popular among shark fishermen since many of the coastal municipalities have ordinaces prohibiting shark fishing along public beaches, and fishing piers often charge large fees for this type of fishing. The artificial reefs provide an ideal alternative since they are conveniently close to shore and are effective shark attractants due to the large schools of bait fish. One shark fishing club estimates that its 38 members fish over the Clearwater reef during 90% of their fishing trips. Shark anglers usually fish at night and it was mentioned that locating the buoys marking the reefs is difficult in the dark. The suggestion was made that lights or reflectors be attached to the buoys.

Charter and party boats fish over the artificial reefs on certain occasions when, these boats are confined to inshore areas by rough weather or fog, during Spanish and king mackerel runs, or when on half-day or intentioned shark fishing trips. More importantly, the reefs benefit the charter and party boats indirectly by providing marked fishing areas for private boat owners and these anglers are less inclined to interfere with the commercial fishing guides by following them offshore to their fishing grounds.

Scuba diving is a popular recreational activity in this part of Florida and there are about a dozen registered dive clubs and an equal number of dive shops in the Pinellas-Hillsborough County area. During the summer months 5 to 6 boats full of divers visit the Clearwater reef each weekend. The shallow depths of the inshore reefs makes them popular with novice divers and with diving instructors who take their students to these reefs for "check-out" dives. Experienced divers prefer reefs constructed in water deeper than 50 feet where there is better underwater visibility and larger concentrations of fish. Deeper reefs would be more attractive to spearfishermen, underwater photographers, and tropical fish collectors.

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[1] This may be contrary to regulations of the National Ocean Survey if such buoys have been published in the NOS and Coast Guard "Notice to Mariners". Before taking any buoy removal action the matter should be cleared with these federal regulatory agencies.

Many divers indicated that reef materials differ in their effectiveness as fish attractants. Generally they listed the materials in order of effectiveness as follows: ships, barges, concrete fish shelters, concrete or steel culvert, and automobile tires.

The survey also brought out the conflicts that often develop between divers and fishermen. This is a long-standing problem which tends to become magnified in a confined area such as an artificial reef. The accusations commonly heard are that divers spear the choice fish or at least scare them away and that anglers show a lack of concern for the safety of divers while operating their boats over and immediately adjacent to the reefs. Divers and fishermen agree, however, that restricting the use of certain reefs to diving and others to fishing would be difficult to enforce and would antagonize both groups. Nevertheless, it would be helpful if guidelines could be established and applicable safety rules and regulations more widely publicized. Both fishermen and divers recommended that spearfishing be discouraged on inshore artificial reefs since they receive the greatest fishing pressure. Hopefully, as the Pinellas County Project progresses and the reefs are enlarged the diver-fishermen conflict will be resolved.

THE COMMERCIAL FISHERMEN'S VIEWPOINT

Corbet Levens

The release from Gainesville concerning the artificial reef conference implies that the newly established 200-mile limit and the growing interest in in-shore artificial reefs are two seperate issues. We maintain that they are closely related and cannot be seperated because they both concern the wise use of our fishery resources. The 200-mile bill or "Fishery Conservation and Management Act of 1976" (PL 94-265) in Sec. 2(b),(1), states that one of the purposes of this act is "to promote domestic commercial and recreational fishing under sound conservation and management principles". Section 306 provides for Federal pre-emption of fisheries management if the state by an act of commission or ommission causes an adverse effect on fisheries management. F.S. 370.02 (2)(a) states that the Division of Marine Resources is to manage such fisheries in the interest of all people of the State, to the end that they shall produce

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Mr. Levens, a commercial fisherman from Ft. Myers Beach, Florida, is President, Organized Fishermen of Florida.

the maximum sustained yield consistent with the preservation and conservation of the breeding stock.

We maintain that a sensible comprehensive management plan is needed or our inshore fishery will be lost. The artificial reef concept has the support of the commercial industry. We feel that the loss of much of our estaurine areas and the added threat of pollution to our shallow water areas makes it necessary to look to artificial reefs as one way to prolong and enhance the commercial and sports fishing in Florida.

The Organized Fishermen of Florida support the concept of artificial reefs to provide areas for sportsmen to fish and to provide Florida with the revenue from these endeavors. We do however feel that these reefs should not be placed in already productive harvesting areas that are being used by the commercial fishermen. Areas not so productive need to be utilized to bring fish there. This provides a place for the sportsmen without interference to the commercial industry which is also a large contributor to Florida's economy.

Being members of the industry we feel that we are in a much better position to determine suitable areas where reefs could be located. We have worked closely with the reef committee in the Lee County area and were instrumental in getting them to move the location of the reef offshore of Fort Myers Beach. . The reef was moved southward down the shoreline maintaining the same depth of water. The reef has been established in that area and the changes were beneficial in that they moved the reef out of a prime harvesting area and also made the new site accessable to two passes (as opposed to one) which will be a safety factor for small boats.

We are concerned about adequate buoy marking and would heartily endorse use of radar reflectors. Also, we would like to be consulted when reefs are planned in prime fishing areas, particularly those in waters less that 25 feet in depth. A short move seaward could remove competition from shallow water gill netting which is so essential to the commercial operator and also avoid nuisance gear hang-ups which would make recreational fishing more free of bottom gear fouling.

Also, OFF would like to recommend construction of some reefs in deeper waters, say 200 fathoms, for commercial fishing purposes. This might be a potential project for the newly formed South Atlantic and Gulf Fisheries Development Foundation.

We have experienced people in all the coastal areas of Florida who would welcome the opportunity to share their knowledge of the bottom, tides and harvesting areas so there would be no conflict among users of the resource.

Our position has remained the same as to the materials used for reefs. We feel strongly that tires cannot remain permanently placed and with adverse weather will become a hazard to boaters, trawlers and bathers.

We see the need for reefs for providing Florida's ever growing tourist industry with places where they can fish and be productive but we must be careful not to take away from the commercial interests. Part of Florida's attraction is her abundance of seafood served in her many restaurants. People expect (and rightly so) Florida seafood in these establishments. If something is not done to preserve our traditional commercial rights we will be serving foreign products. A sensible comprehensive plan is needed.

The 200-mile bill mandates that each state provide a statewide fisheries management plan or the Federal government will step in and do it for them. If we do not utilize our resource to its maximum sustainable yield foreign boats will be allowed to fish our shores and we in turn will have to import our own product from a foreign country.

Working together we can establish a series of reefs which will better the fishing for the sportsmen while at the same time fulfill our obligation to provide food for our country and a livlihood for the members of our industry.

A SPORTS FISHING EDITOR'S VIEWS ON REEF FISHING

Bob Bender

After 20 years of sport fishing in Florida, mingling with sport fishermen and sport fishing groups, and reporting on fishing conditions and catches, I can draw one conclusion: "fishing ain't what it used to be." Catch doesn't equal effort, nowhere near like it used to.

The responsibility can largely be placed on dredge and fill operations, destruction of nursery grounds, pollution of estuarine and shallow coastal waters, and increased fishing pressure.

One salvation for the average recreational fisherman lies in the development of accessible artificial reefs. This is particularly valuable for the tourist-fisherman who has no knowledge of good natural fishing areas, can't afford frequent hire of a charter boat, but does have access to a well-marked artificial reef where the probabilities of some results seem more apparent than a hit-or-miss venture.

Mr. Bob Bender was Outdoors Editor of the Manatee Times and is a member, Manatee Reef Committee, Bradenton, Florida.

Originally--back in the 1950's--four reefs were constructed in Manatee County waters: one in the Gulf of Mexico, one in Sarasota Bay, one near the mouth of the Manatee River, and one farther up the river. The reefs soon provided encouraging productivity. However, inadequate maintenance resulted in siltation through wave action that brought the necessity for reef refurbishment and maintenance into sharp focus. These reefs were spearheaded by the Manatee Chapter of the Izaak Walton League, with actual construction work by the Manatee County Engineering Department.

Some 20 years later another committee, known as the Manatee Reef Committee, was formed for the purpose of not only promoting artificial reef construction, but providing adequate monitoring and maintenance for continued productivity.

Four proposed reefs in the Gulf would be approximately three and seven miles off the north tip of Anna Maria Island and three and seven miles off Longboat Pass. Each would be on easy compass course to minimize navigation problems and sited so as not to interfere with other water traffic.

This latest committee was developed under the sponsorship of the Manatee County Chamber of Commerce in an effort to promote better fishing for resident and tourist alike.

THE SPORT DIVER'S INTEREST IN ARTIFICIAL REEFS

Norine Rouse

Divers enthusiastically endorse the educated placement of artificial reefs and are increasingly attracted to them as a source of personal satisfaction, excitement, sport, curiosity solving, and as a means of observing marine organisms and phenomona in manmade but near-natural conditions. (Although it must be kept in mind that the reef is a sanctuary and no collecting is allowed with SCUBA gear).

Ms. Rouse is a NAUI instructor at Palm Beach Atlantic College, Director, SCUBA, Inc. of Palm Beach, and past member of the Executive Board of Marine Technology Society of Palm Beach Section.

These artificial reefs are a tourist attraction for the area and therefore an asset for Florida's economic well-being.

(A slide presentation covers examples of habitat formation, seasonal changes in population density and diversity, effect of tidal action, fairly accurate accounts of recurring seasonal visits by certain well-identified marine vertebrates and erosion and movement of deposited reef materials.)

THE MERCHANT SHIPPERS' VIEWS ON ARTIFICIAL REEFS*

E. P. Sawyer

As man has progressed in recent years, with improved techniques producing increased commerce and leisure activities, there have been numerous problems associated with this growth. One of these problems is the joint use of our ocean areas by all interests. We have the traditional ocean vessel journeying to ports around the world; the commercial fishermen trawling and netting; the sport fishermen with his varied activities; and in recent years the offshore oil development. All of these uses, and a few more, have grown in size and quantity and sophistication. It behooves all of us who have an interest in any of these activities to find a workable method for the joint use of our ocean areas.

From a ship operator's viewpoint, artificial reefs are man-made submerged hazards to navigation, hidden from the eye and radar. As such, they can endanger the safety of ships, their cargos, and those utilizing artificial reefs. The manifold liabilities are obvious. Our greatest concern however, is not the reef under water, but the small fishing boats that can be expected to congregate over a successful reef. During periods of adverse visibility these small craft are almost impossible to detect.

Captain E.P. Sawyer represents Lykes Bros. Steamship Co. Inc. with headquarters in New Orleans, Louisiana. He also represents the American Institute of Merchant Shipping and is Chairman of the AIMS Navigation Working Group which coordinates that organization's reef activities.

*Captain Sawyer's statement was read to the Conference by Dr. William Seaman, Jr., Assistant Director, Florida Sea Grant Program.

Permit procedures are understood, and the Steamship Industry participates. However, frustration is the end result of many attempts to make meaningful inputs during proposal, review, permit issuance and reef installation. For example, some permit requests seem to be from somewhat elusive groups; proposals are quite often submitted, revised, withdrawn, and resubmitted with little order, thereby frustrating attempts on the part of government/industry to follow developments in a logical fashion. Intensified screening of permit requests for detail/accuracy/validity/intentions, prior to invoking public process would seem to be in order. On one day a single District Engineer issued seven different public notices covering 12 proposed reefs of all types - making a total of some 27 proposed reefs in process in that District, with 30 days for comment. There are 16 District Engineers who become involved with offshore reef proposals. Being on Notice mailing lists does not insure receipt, and 7 - 10 day mail transit time is not uncommon, leaving little time for interested parties to review and respond. One reef was installed four miles from the permit location - and other reefs have been mis-located - indicating a need for tighter construction controls. The shipping industry could, we believe, be helpful in all of these phases if offered a coordinated mechanism for doing so.

Every proposed reef should ultimately be reviewed on individual merits and criteria. However, certain general standards for locating, sizing and marking reefs would be in order, as guidance to those contemplating a permit request. From the viewpoint of deep-draft ship operators, the following are major factors in safe location and use of artificial reefs:

* Ship traffic density and familiarity with the waters.
* Types of transiting vessels, and their cargoes.
* Vessel size-length, beam, draft and maneuvering characteristics.
* Prevailing and extreme weather/sea conditions, especially as they affect visibility.
* Water depth and related bottom contour.
* Location in relation to known historic traffic patterns, safety fairways/sea lanes, anchorages, sea buoys, pilot stations, and other deep-draft maneuvering areas.
* Easy access to reefs by pleasure craft with minimum use of deep-draft channels/lanes.
* Type of fishing craft and activity on the reef.
* Adequate reef marking - day and night - for proper radar and other navigational identification.
* Avoidance of small craft jamming of critical VHF radiotelephone channels dedicated primarily to navigational, safety, distress and calling usage such as channels 13, 16 and 22.

Careful analysis of these factors in relationship to the proposed reef will result in knowledgeable selection of minimum distances to provide adequate isolation of the reef, minimum water depth/clearance over the artificial obstruction, and maximum safety for all involved.

Having in mind the constraints implicit in working under an 1899 Act, the Corps of Engineers has done an admirable job in attempting to protect all interests to date. But, the complexity and multiplicity of reef proposals require a central coordinating agency to insure meaningful participation by all government, industry, and public interests, both domestic and international. Under a number of conventions, laws and regulations at least five government agencies - Corps of Engineers, U.S. Coast Guard, Environmental Protection Agency, National Marine Fisheries Service, National Ocean Survey - have involvement. Time is not as critical in reef permit consideration as in some other permit activity, and for this reason provision of a coordinated review mechanism is reasonable.

A regularly scheduled annual or semi-annual meeting of representatives of all legitimate interested parties to review and recommend on permit requests covering areas involving deep-draft shipping would be most helpful. Consideration for the safety of the sport fishing craft should be given primary attention.

It is recommended that the pertinent government agencies jointly develop a standard set of permit request details and artificial reef criteria which must be met by reef proponents if their request is to be processed. Such uniformity would be of benefit to all parties, including the proponents. Under today's conditions, the compatibility of ships and reefs is doubtful.

FLORIDA'S SUBMERGED ARCHAEOLOGICAL RESOURCES

Wilburn Cockrell

The Florida Department of State, under authority of Chapter 267, of the Florida Archives and History Act, has the responsibility for locating and protecting terrestrial and submerged archaeological or palaentological sites in the State of Florida. On the basis of research and surveys, there currently are four closely protected "Reserve" sites in State waters.

Mr. Wilburn Cockrell is Administrator of the Underwater Archaeological Research Section, State Underwater Archaeologist, Florida Department of State, Tallahassee, Florida.

While only two-three hundred shipwrecks have been recorded, it is estimated that there may be as many as 5,000 wrecks in Florida waters, few of which are believed to be treasure ships. Parenthetically, contrary to popular belief, treasure hunting is rarely, if ever profitable, although the State has issued more than fifty (50) contracts, to this date.

The real importance of protecting known and potential wreck sites is the value of the cultural base data involved. Obviously, the covering of such sites with artificial reef materials, particularly containing ferrous materials, would interfere with remote sensing surveys and, on that basis, the State has the moral and legal responsibility to review permits for construction of artificial reefs, to assess potential impact. While masking a site might, in some instances, be desirable as it would conceal the site from the depredations of treasure hunters, any permit application filed with the Corps of Engineers of the State Department of Environmental Regulations is routinely checked. In most instances, this is handled quickly because this agency has taken the position that most dredge and fill or other such operations generally constitute minimal threat to sites and few, if any, objections have been registered. In areas where a treasure hunting contract has been issued, a survey is required to resolve any conflict. However, the Federal Government, through the National Park Service, contends that covering an archaeological site constitutes a major threat to the site. Thus, the two agencies have differing philosophies on this subject; nevertheless, under the National Environmental Preservation Act of 1966, as amended 1976, and Executive Order 11593, such impacting acts must be mitigated. This can be effected either by slightly moving the proposed project or excavating the archaeological site. Furthermore, the federal regulations prescribe the State Historic Preservation Officer as the reviewing agent. Thus the needs for permit review, by our agency, as the S.H.P.O. is within our Department.

Our normal procedure is to check the application against the Master Site File. The agency has furnished the Jacksonville Corps of Engineers with a map of high probability areas, (based on known sites, historic documents relating to fleet routes, and historic trade) in which a survey would probably be requested if massive bottom disturbance were contemplated. Artifical reefs, however, generally are not so categorized. In the future, artificial reef applicants could facilitate our survey(s), when required, by furnishing boats and people familiar with the area; in such circumstances, this agency would volunteer its limited field survey services. To date, we have not required the applicant to defray survey costs; boat and trained personnel availability, on a volunteer basis, would probably eliminate any probability of such cost arising. This agency endorses a centralized permitting procedure and further feels that a pre-check with us could probably reduce the currently normal two-four week review period to a fraction of that time while still maintaining our legal responsibilities. We recognize the environmental and socio-economic values of reefs and have a strong desire to work in full cooperation with interested applicants under the conditions outlined.

SECOND TECHNICAL SESSION
John C. Briggs, Chairman[1]
Fred A. Kalber, Moderator[2]
R. F. McAllister, Moderator[3]

REEF MADNESS

Michael Della Poali[4]

It is commonly recognized that throughout the country people involved in artificial reef construction tend to make the same mistakes. Through a series of slides the experiences of the Pinellas County (Florida) artificial reef program will be illustrated.

A tire unit composed of four tires with two holes punched in each tire 180° apart, ballasted with approximately fifty pounds of concrete and banded together with plastic strapping and nylon buckles proved satisfactory.

Other efforts included the mounding of individual tires with holes also punched in them; each mound consisting of as many as five hundred tires. These mounds eventually separated and spread out evenly along the bottom, a portion of them filling with sand.

Fifteen to thirty tires were banded together in a loose clump with holes punched in each tire to allow air to purge. Difficulty in purging all the air was experienced and as a result of this the unit proved unstable.

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[1] Dr. John C. Briggs is Chairman pro-tem, Marine Science Department, University of South Florida, Bayboro Campus, St. Petersburg, Florida.

[2] Dr. Fred Kalber is Supervisor, Marine Research Laboratory, Florida Department of Natural Resources, St. Petersburg, Florida.

[3] Dr. R. F. McAllister is Professor, Ocean Engineering, Florida Atlantic University, Boca Raton, Florida.

[4] Mr. Michael Della Poali is an artificial reef construction specialist with the Pinellas County Artificial Reef Program, Pinellas County, Florida.

Large truck tires and earthmover tires sunken individually laid flat on the ocean floor and eventually filled with sand. When these tires were put in any configuration without ballast they also proved unstable.

The currently used method consists of sixty half-tires (split through the center tread) per unit. Six of these units are tied together with nylon strapping producing a large bundle of one hundred and eighty to two hundred tires. As many as thirty of these large bundles are deposited at one time. Monitoring of these units over a three year period has indicated that this configuration is stable and an effective fish attractor.

Concrete culvert, concrete piling and concrete rubble are excellent fish attractors. The practice of spacing this type of material in small piles (thirty feet in diameter) fifty to seventy five feet apart seems to be very effective.

Steel corrugated culvert is light and unstable in any strong current, has a tendency to fill with sand and also oxidizes rapidly, although it is a fair fish attractor while it lasts.

Common household appliances (stoves, kitchen ranges, dryers, etc.) are unstable and will oxidize and eventually disappear.

Any steel or fiberglass ships or barges are excellent fish attractors. Only very large wooden ships are stable and only when they are heavily ballasted.

All of the material discussed can be difficult and expensive to transport to artificial reef sites. How difficult and how expensive can only be determined by examining very carefully the many and varied situations in each individual community considering construction of an artificial reef.

The building of any artificial reef is always a large undertaking. To make the project a successful venture requires proper and thorough planning.

THE DEVELOPMENT OF FISH COMMUNITIES

Gregory Smith

Artificial reefs, like natural reefs, attract and concentrate marine fish and other benthic organisms by providing shelter, additional food sources and firm substrate for detachment and orientation. The development of fish communities can best be described as the changes brought about in these biological associations with time after the reef is once placed on the ocean floor. Studies by the Florida Department of Natural Resources of natural and artificial reefs under approximately the same environmental setting have found them to be virtually identical in terms of absolute species composition.

A unique study opportunity occurred in 1971 when the summer red tide bloom resulted in mass mortalities and near extirpation of natural reef biotas from approximately 700 square miles of the West Florida shelf. Prior monitoring for about three years provided a base for determination of faunal mortality. Post-red tide studies provided data on the pattern and time sequences of the reef reoccupation. Censuses of reef fishes were conducted between 1970 and 1974 at two reef sites off Sarasota, Florida, via SCUBA, along a 300 meter transect line.

Via slide media the reef structures, description and locality are shown. Reef No. 1 is approximately 8.5 nautical miles, 235°, off Sarasota in 40-45 feet of water and runs approximately 1000 feet as a generally 1-2 foot high limestone ledge. Reef No. 2 is about 11 nautical miles off, 240°, Sarasota; depths are 50-54 feet and the ledge rises 4-5 feet in places.

About 77% of the resident fish populations at reefs shallower than 60 feet perished during the red tide; the remaining species survived only as remnant populations. Post-red tide colonizers were generally deep-water forms that temporarily replaced ecologically equivalent species lost in the red tide. The colonization pattern for both stations was essentially identical.

Principal observations were: red grouper were completely annihilated and did not reappear for nearly one year; gray angelfish, previously uncommon, colonized in abundance within 2 months; butterflyfish and surgeonfish, rare or absent previously, were conspicuous post-red tide colonizers; maximum diversity of 27 species was attained after about one year of colonization.

Mr. Gregory Smith is marine biologist, Marine Research Laboratory, Florida Department of Natural Resources, St. Petersburg, Florida.

Observations support the conslusions that: Artificial and natural reefs are considered faunistically identical in terms of species composition; the fish community in the eastern Gulf apparently develops according to predictable successional processes; most fish arrived as postlarval colonizers recruited via the plankton; maximum species richness occurred within one year; a stable species composition was achieved within three years; colonization of artificial reefs may be more rapid due to transfer from established populations at adjacent natural reefs; and artificial reefs fulfill their intended function.

ARTIFICIAL REEF ENHANCEMENT UTILIZING MIDWATER ATTRACTION STRUCTURES

Thomas D. McIlwain and Ronald R. Lukens

In 1974, the State of Mississippi began constructing two artificial fishing reefs in the northern Gulf of Mexico off the Mississippi coast. A total of five Liberty ships were acquired from the Maritime Administration. Two ships were placed in fourteen meters of water and three placed at twenty meter depths. The ships were cut to within 4.5 meters of the keel, cleaned, and then sunk at the designated reef sites. In cutting the ships down, the only remainder was a 126.7 meter saucer with very little vertical relief. The first ship was sunk June, 1975, and the second, May, 1976.

SCUBA observations on the reef one week after sinking indicated that a number of reef type fishes were recruited, but there was a lack of pelagic species.

Since our objective was to attract the largest variety of fish to the reef site, several previously reported attracting materials and structures were investigated. However, upon further study, it was felt that these type structures were not permanent and would not meet our needs, so it was decided to use midwater attraction devices made of polyvinyl chloride (PVC). The structures deployed were constructed of 5 cm. PVC pipe cut into 3 meter sections and capped at one end. A total of 160 of these PVC attractors were attached to cables that had been salvaged in the original scrapping operation and which had been secured across the bottom of the two test hulls. The units were made on shore, filled with water at the site, and carried to the bottom and

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Messers McIlwain and Lukens are associated with the Gulf Coast Research Laboratory, East Beach, Ocean Springs, Mississippi.

secured to the cables by divers. The units were then filled with air from the divers' regulators. The first 80 midwater structures were placed on the stern of the first ship sunk in June, 1975. The other 80 were placed on the second hull, sunk June, 1976. SCUBA observations were made on both ships over periods of four and ten months respectively. The bow of each ship served as a control area.

Dives made at the proposed reef site prior to sinking of the hulls had revealed no observable fish. Subsequent dives indicated reef fish were being recruited within one week of the sinking. The first to appear were the Rock sea bass and the Red snapper. The numbers of these fishes continued to increase with time and a number of new species were added to the icthyofaunal list on each dive. Observations of bait fish schools and pelagic fish made while SCUBA diving at the experimental midwater fish attraction sites were not unlike those reported by Klima and Wickham (1971), Wicham, et. al. (1973), and Wickham and Russell (1974). Although schools of bait fish (rough scad and scaled sardines) were observed sporadically, the shallow depths (14 meters) at which the structures were placed may have accounted for the observable differences.

The spadefish was the most commonly observed fish, ranging up to 2.25 kilograms. Large numbers of sheepshead in breeding condition were found in association with the structures in March and April, 1976.

The occurrence of truly pelagic fishes, such as Spanish and King mackerel, crevalle jack, blue fish, and blue runner, occurred in the summer in association with higher temperatures and salinities. Although angler catch data were collected in July, 1976 only, the catch of these species was higher around the structures than in the open Gulf waters several kilometers away from the reef site. Diver observations indicated a larger population of these species at the reef site than was evident from the reported angler catch, probably due to the ineffective fishing methods employed by the anglers. Because of poor visibility, no information is available on the distance that the schools ranged away from the structures.

Our observations confirm that a resident population of fish has been established in and around the structures. The PVC pipe has been down for almost three years and is still in place. The low PVC pipe cost, ease of deployment, and permanency of its nature makes it an ideal material with which to construct this type of underwater device.

THE "TROLLING ALLEY" FISHING SYSTEM

DeWitt Myatt

The South Carolina Wildlife and Marine Resources Department has developed a new mid-water fish attractor concept for increasing the catch rate of the migratory pelagic species. This involves the construction of a "trolling alley" adjacent to new or existing bottom reefs, natural or artificial, in such a manner that the trolling activities will not interfere with the benthic fishes. An ancillary benefit, the attraction of bait fish, enhances both trolling and bottom fishing operations.

Essentially, the gear consists of a vertical array of six automobile tires suspended by a float made from an empty 50 pound Freon cylinder. The tires and float are strapped together with either polyetheylene rope or more recently nylon "Dymax" strapping. A quarter inch steel cable is used to attach the assemble to a 300 pound concrete anchor. By adjusting the length of the steel cable the tires are suspended at midwater or any desired level.

There are many advantages to this type of structure. The cost factor is very reasonable. Empty and surplus Freon cylinders can generally be obtained from refrigeration and air conditioner dealers at little or no cost. In fact, the dealers are usually glad to clear their storage area of these containers. The steel cable costs South Carolina about six cents per foot. If one shops around, especially at junk yard auctions, cable can be found at favorable rates. Arrangements for construction of the concrete blocks can generally be made at modest cost with concrete fabricators or "ready mix" dealers by utilizing waste concrete. The reinforcing rod can be obtained fairly reasonably, if some shopping is done. The units constructed by South Carolina, using surplus items and cooperation of suppliers, cost $1.48 and labor, including deployment, was $0.52 bringing the cost to approximately $2.00 per unit.

The units were set at 100 foot intervals forming a one-half mile trolling alley. Within 30 days of installation, a population build-up was apparent. An estimated 200-300 thousand scad, anchovies and sardines were seen clustered among the structures. King mackerel, Spanish mackerel, barracuda, cobia and amberjack prowled around the schools of bait. Offshore possibilities could include dolphin and certain of the billfish. With each unit supporting a bait and predator population the possibility of 30 strike situations is developed.

DeWitt Myatt is Artificial Reef Coordinator, South Carolina Wildlife and Marine Resources Department, Charleston, South Carolina.

Experimental trolling under controlled conditions revealed that the midwater structures increased the yield of pelagic game fish by 22.5% over a regular artificial reef. An 80% higher hield was obtained on the reef improved with midwater stuctures than in the unimproved ocean nearby.

The system is not witout some problems. The thin casing on the Freon containers is subject to steady corrosion. When the float fails the remainder of the unit then sinks to the bottom but still has fish attractor capability as benthic material. This is an important safety feature because it reduces the chance that the tires and float will break free from the anchor and drift on the surface where they could present a hazard to navigation or contribute to the litter on the beaches. No units used in the 6 month experiment were lost to drift.

Liasion with the state and federal permitting agencies is required since the half-mile string of floating Freon tanks does present some concern to the unknowledgeable navigators.

The system has been enthusiastically accepted by the sport, and even the commercial fishing community and is being considered by other states where pelagic species are abundant.

A TIRE BALER MANUFACTURER'S EXPERIENCE

John F. Loudis

As manufacturers of baling equipment for over 40 years, the company I represent has designed balers for numerous industries. Some of these projects have been most challenging, however, none can compare with the seemingly insurmountable problems we encountered in trying to design a baler to bale scrap automobile tires.

We were first contacted about this program by a state agency, who was active in utilizing scrap tires in building artificial reefs, on approved ocean sites. It has been sufficiently documented that scrap tires, when properly placed on the ocean bottom, definitely enhance both sport and commercial fishing. The agency was looking

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Mr. John Loudis is Assistant to the President, National Compactor Company, Jacksonville, Florida.

for a means to reduce the extraordinary labor intensiveness and prohibitive handling costs involved in disposing of tires. Their feeling was that if a manufacturer could develop a baler that could handle more than six tires at a time, it would significantly reduce these costs. Initially, we tried baling the tires on a super high density press we had designed for a major manufacturer of heavy duty cables. The results of the test were disastrous. We did several thousand dollars worth of damage to the press and could not believe the tremendous resiliency of the tires. However, it did whet our appetite and we researched the problem further and I am happy to report that we have now successfully made bales consisting in excess of 100 tires in dimensions approximately 36"x48"x60". These bales weigh in excess of 2,000 pounds with a cubic density exceeding 50 pounds per cubic foot. Additionally, we tested these bales in the ocean to see if the voids filling with water would allow the bales to sink to the ocean bottom. Again, we were pleasantly surprised to find that they did sink in 30 feet of water at a rate of 2 feet per second and these bales are perfectly suitable for use in an artificial reef program. Obviously, the cubic density of the bales is in excess of 64 poinds per cubic foot when the voids are filled with water.

Additionally, many other benefits are in order since transshipping of tires has always been a major problem. The bales have increased payloads on 40' rail cars from less than 50,000 pounds to an excess of 100,000 pounds. The same holds true with transshipping bales by truck. On a 40' trailer we are now capable of shipping payloads in excess of 40,000 pounds, which is approximately twice what it has been in the past.

All this not withstanding, there is a dramatic reduction in labor, making the utilization and handling of tires much more cost effective.

We have also found that municipalities that are faced with serious tire disposal problems in landfill areas view this breakthrough as a definite possibility ofr creating balefills in lieu of the conventional method of disposal. This would allow for a dramatic reduction in the amount of space required for tire disposal.

Additionally, it seems that with the shift in economics of oil versus other forms of energy, many companies are currently investigating processes to recover the BTU value, as well as other chemical by-products, that can be extracted from scrap tires. Since our involvement in the area of tire disposal, it has become apparent that in the not too distant future, there may well be an intrinsic value assigned to scrap rubber as there is other forms of scrap by-products, such as aluminum, paper and other forms of fiber.

It is with total appreciation to the artificial reef program that we were first involved in this area, which has obviously grown

into a much broader scope in its application. At this time, we have had contacts from people all over the world who are faced with the same problems of tire disposal. This country generates in excess of 200 million tires a year and it seems that our problem with disposal is shared by other nations worldwide.

I do not wish to imply that our unique development is the answer to the resolution of this problem. I only suggest that it is a dramatic breakthrough in resolving one of the most critical areas, that being material handling and disposal.

ARTIFICIAL REEF AND BEACH EROSION CONTROL

Y. H. Wang

It is generally known that when waves feel the ocean floor they break. Much of the wave energy is dissipated as a result of the breaking. It is conceivable that the intruding elements of artificial reefs may trigger large storm waves to break before reaching the shoreline and therefore, strongly influence beach stability.

In 1960, Professor Inman of Scripps Institute of Oceanography observed at Algodones in the Gulf of California, that the natural occurrence of a rocky-toe structure offshore from the beach permitted the beach to withstand more wave action than was normal for a beach of the same type. This idea was explored later by the Corps of Engineers in California for the Department of Transportation. The latest laboratory investigation was reported by Chatham of the Waterways Experiment Station (WES). Typical sample results of the WES investigation are shown in the following two figures.

In figure 1, the laboratory beach profiles, with and without a toe structure, were tested to waves of 10 seconds period and 8 feet high. It is apparent that the toe structure significantly reduced the abount of beach material lost seaward of the toe structure.

Dr. Y. H. Wang is Assistant Professor, Coastal and Oceanographic Laboratory, College of Engineering, University of Florida, Gainesville, Florida.

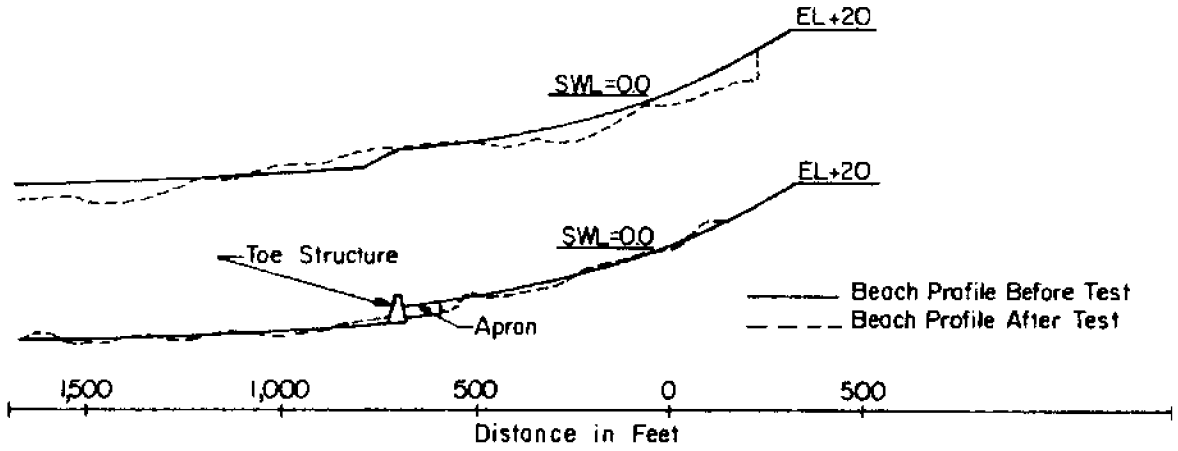

Figure 1

In figure 2, the same laboratory beach profiles, and same wave conditions as they were in figure 1 except the toe structure were placed at a different depth and larger distance from the shoreline. The results indicated that the toe structure has little or no beneficial effect on the beach material lost seaward of the toe structure.

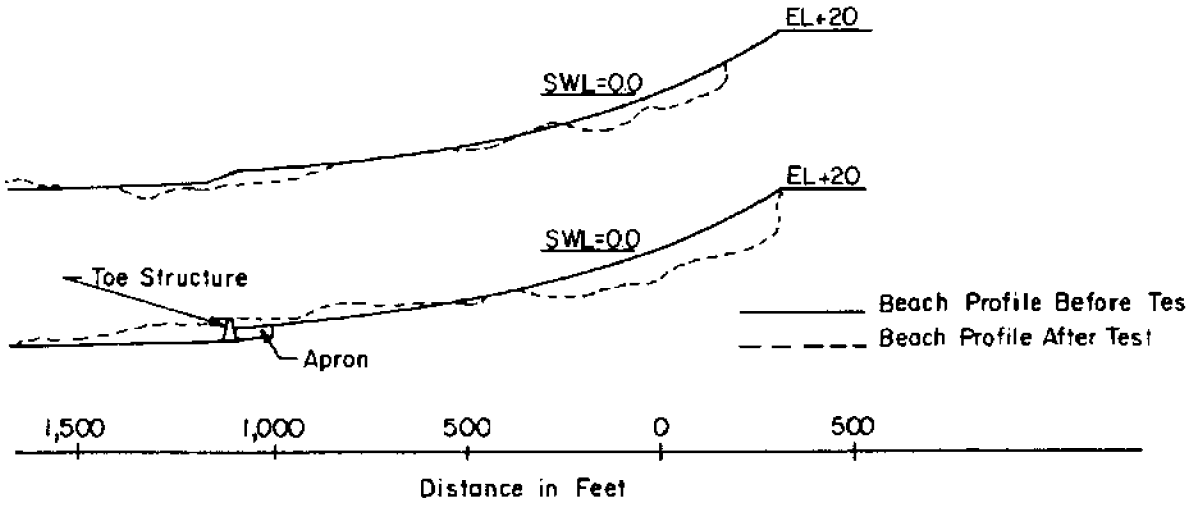

Figure 2

An organization called "Sabacon Reef for Beach Erosion Control" has formed in Vero Beach, Florida. They find the Rio Mar reefs do have a stabilizing effect on the beach there. Most recently, the use of sand bags lying parallel to shore has caused sands to deposit on the shore.

However, the pertinent questions for properly designed offshore reefs are still waiting to be answered. Such as (1) dimension of the submerged reef structure, (2) depth of submergence, (3) relative location to the shoreline, (4) structural stability of the submerged reefs, and (5) effects on the sediment movement.

All those preliminary investigations mentioned above have shown that the usage of offshore reefs as a means to combat beach erosion is possible and encouraging. Let us use one stone to kill two birds, i.e., reefs for attracting fish and for beach erosion control.

ECONOMIC ASPECTS OF ARTIFICIAL REEFS

Eila Hanni

In contrast to the rather extensive research on the biological and engineering aspects of artificial reefs, little, if any, concerted effort has been directed toward analyzing the economic benefits and costs of such reefs to the local communities or the state concerned. An opportunity to conduct such a systematic benefit-cost study developed in 1976 under the auspices of the University of South Florida through a Florida Sea Grant College grant.

The study was confined to actual and projected recreational benefits stemming from an ambitious artificial reef construction program undertaken in Pinellas County, Florida, by local government. Based upon the belief that the major justification for reef construction must lie in the recreational benefits, the question was posed in the study: "Can this type of construction be justified on the basis of the benefits it brings to the recreational anglers and divers at the present level of user demand?" Other elements, such as beach erosion control, commercial sales of charter boat catches, commercial fishing and solid waste disposal were intentionally not included.

A good method of estimating reef benefits takes into account how much money users are <u>willing</u> to spend for this type of recreational activity rather than how much they <u>actually</u> spend. A conceptual demand curve was estimated to determine the answer. Complicating its

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Dr. Hanni is an Assistant Professor in the Department of Economics, University of South Florida, St. Petersburg campus.

estimation were the facts that the reefs were built with public funds and no costs are assessed for access and use of the reefs. Also, a reasonably reliable sample of users should be interviewed if a willingness to spend pattern was to be developed. Unfortunately, inclement weather caused our efforts at interviewing to fall short of the desired. As a resolution, we relied on a judgmental demand curve technique which, simply put, averages the amount the least and the most eager users are willing to pay for this recreational activity.

Four categories of users were established: (1) Sunday anglers, characterized by small boats (16' - 20'), family or "companion" type of fishing effort, usually during weekends, and cluster rather than solitary boat activity; (2) sports anglers, who generally use larger craft (21' or longer), or a charter boat that carries 4-6 persons; (3) shark anglers; and (4) sports divers, who may or may not fish.

Taking the Sunday anglers as an example, the judgmental demand curve reflects an average willingness to pay $20.00 (a high of $40.00 and a low of $0). Total benefits per day would then equal $20.00 times the total number of users.

The supply curves involve both construction costs and user costs. The publicly funded Pinellas County reef construction data were used as a starting point. Adjustments were made for voluntary labor, donated materials and site rentals, available at below market prices, to reflect the true opportunity costs. Thus, considerable imputation was involved in developing figures on dollars spent per square foot of reef bottom constructed. As the Pinellas program expanded, the average cost per square foot of reef bottom decreased reflecting more efficient use of facilities and personnel, and increased supply of inputs free or below market prices. Even then, reef construction is not cheap. The cost of a split tire in place at the reef bottom was determined to be $2.74 in 1973-74, but dropped to $1.30 in 1975-75. By contrast, tires can be buried in local land fills at an estimated cost of 2 cents per tire. Thus reefs are not a cost efficient means of tire disposal, but must stand on their own merits as recreational sites.

On the basis of fish counts obtained by Gregory Smith through various techniques, and the size of a catch estimated to produce a satisfactory fishing day, available reef bottom was converted into potential fishing days per year. There were 5,275 of these user days available in 1973-74 as contrasted with 12,528 during 1975-76. Cost per trip per Sunday angler, using cross-check methods, was determined to be $15.00. Similar calculations indicated an average of $39.00 per sport angler, $29.00 per sport diver, and $25.00 per shark fisherman. The total costs by user type and volume were then estimated on various alternative assumptions regarding the useful life of the reef.

The fundamental conclusions on reef construction are now apparent. In the first place, reef construction is justified if the discounted present value of benefits exceeds costs. Secondly, optimum size of

a reef is reached when the average willingness to pay equals the marginal cost of capacity and use. Our results indicate that:

1) The present reefs yield favorable benefit-cost ratios if devoted exclusively to Sunday anglers.
2) Sports anglers use (Category #2) will not justify reef construction; at best, it can exist through subsidies from Sunday anglers.
3) Shark anglers do not compete with Sunday anglers or sport anglers, since night fishing and a separate species are involved; their benefits about equal costs, leaving user volume indeterminate.
4) Reefs designed solely for diving yield by far the lowest benefit-cost ration -- far below one.

In the light of this study, reef construction in Pinellas County can be justified only for Sunday anglers. Reef construction for sport anglers, divers or shark fishermen alone or in any combination is not justified on the basis of expected direct user benefits. Conclusions for other times or places may be different. For example, in Pinellas County, a relatively small number of people can afford to charter boats or own larger boats for sports fishing. The relative use and ownership of diving gear is low among the predominant older age brackets. To date most of the reefs, and those covered in this project, are in nearshore waters of fairly moderate depths. To go seaward from the 25-30 foot depth would increase construction costs substantially and the above conclusions might not then apply. However, if present reef materials were to be displaced by the use of large sunken vessels, the benefit-cost ratios for sports anglers might improve since costs would be less. The foreseeable growth of population, changes in its age structure and incomes may well shift the demand curves of sports anglers and divers sufficiently far out to justify some kind of reef construction farther offshore for them provided, of course, that the costs of sports angling and diving do not rise proportionately.

ADMINISTRATION OF ARTIFICIAL REEF PROJECTS

James F. Shinholzer, Jr.

Mr. Shinholzer is Director, Pinellas County (Florida) Mosquito Control, Clearwater, Florida and directs the Pinellas County Reef Program.

(Ed. note: A slide presentation)

The matter of administration at the local level must be considered in any effective and efficient artificial reef building program. Such matters as budgets, number and types of personnel, equipment and materials, communications, logistics, and even public relations are involved.

A first consideration, after determination of a demonstrated need and expected benefits, is the number of reefs to be constructed. Engineering aspects and permitting then follow. Ten reefs were originally planned in Pinellas County, Florida, of which nine are in the process of construction. Six sites are off the west coast of the peninsula about five miles off-shore in approximately thirty feet of water.

Two are a little further out, about twelve miles, in approximately fifty feet of water, and one deep reef, capable of accepting a Liberty ship, about twenty-five miles out and ninety feet deep. There is also one reef site in Tampa Bay off St. Petersburg.

Costs can escalate even when full advantage is taken of contributed human and material resources. The County's barge, approximately 70' X 30', cost about $60,000 with local municipalities sharing the cost. To replace today, on an actual cost basis, would require $90,000. A crane for the barge, an absolute necessity, was made available by the local Mosquito Control District on a semi-permanent loan so no purchase cost was involved. However, it is a cost item to be considered, since an operator's time is involved.

To assemble materials for the reefs, Pinellas County operates two staging areas, one in the northern part of the county and one in the southern area. Cost will vary depending on the needs of the facility. The last staging area developed by the County required a dock, fence, paving and work buildings. Even though the property was free, an area approximately 75' X 250', the improvements cost about $40,000. This also included plumbing and electrical installations. Equipment for the staging area included a forklift (5,000 lb. capacity) at $12,000 and a tire splitter costing $4,000. As indicated, you will have a monthly water, electricity, and telephone service charge.

Many surplus items are available at little or no cost. Tires are plentiful. For our needs, we found they performed best split circularly and bundled in units consisting of approximately thirty tires. We have three tire splitters, costing roughly $4,000 each, and are capable of splitting about 125-150 tires per hour. The tires are strapped together using polyester cord strapping which comes in 1,000 yard rolls and cost about $30 per roll. Our barge can handle up to 5,000 tires per load which represents about a week's splitting effort. Therefore, we need other materials to keep the barge operational.

Concrete or metal drainage pipe and other concrete rubble generated through various types of construction are generally available at no cost, providing you can haul the material away yourself. Pipe manufacturers routinely break pipe in the testing process. If you intend to use surplus water or sewer pipe, you must consider the cost or rental of a lowboy, since pipe may range from four to sixteen feet in length and weigh up to or over 5,000 lbs. Your crane's load capacity will determine the size pipe you can use.

As far as materials are concerned, much of it can be obtained gratis from local manufacturers, street and highway departments, contractors, local tire and junk yards. Co-operative arrangements can benefit the person wishing to dispose of surplus materials and constibute to the public relations posture of the donor. However, a word of caution - look a gift horse in the mouth. Some surplus items, particularly derelict boats or barges, require towing to the reef sites. This can involve excessive costs as well as produce traumatic experiences.

Buoys can also run up your cost. We make ours using fiberglass pipe and our basic can buoy cost about $150 each. We use 3/8" chain which costs approximately 92 cents per foot. This can add up depending on the number of buoys required. Some other cost to possibly consider would be a sextant or loran, and adequate diving equipment (tanks, regulators, pressure gauges, wet suits, masks, fins, etc.) if your program will involve using divers. Personnel cost will depend upon the local situation, but considerable physical effort and time is required. Our program utilizes a barge operator, three divers, a crane operator, and seven EJP's (emergency job personnel) for the two staging areas.

The County's program is locally funded, mainly by the County with some help from municipalities. It is estimated that our siting, engineering, storage, transport, construction and maintenance cost run about $100,000 per year, including all personnel and adjunct administrative costs.

JACKSONVILLE OFFSHORE SPORT FISHING CLUB

Charles E. Schutt

The Jacksonville Offshore Sport Fishing Club, with a current membership of 800 recreational fishermen, initiated its reef-building program in 1960 with the construction of Montgomery Reef approximately 8.5 miles NE of Mayport, Florida. This reef was constructed of 200 automobile bodies and 1200 junk appliances. In 1961, 7000 scrap tires and broken cement culverts were added.

Since the building of Montgomery Reef in 1960, additional artificial reefs have been added to the waters off of Mayport, Florida. Blackmar Reef, Busey's Bonanza, Tanzler-Waters, and Casablanca Reef were formed by sinking tugboats, dry-docks, barges and other materials. Paul G. Mains Reef was built in 1967 with approximately 300 tons of concrete culvert and 200 automobile bodies.

In recent years, old tug boats were added to Busey's Bonanza and Blackmar Reefs, and one old tugboat was placed in the Main Fourteen-Fifteen area and one on Nine Mile Reef. In 1975, 3000 scrap tires were added to the club's original reef, Montgomery Reef. In 1977, 400 tons of concrete culvert were added to this same reef with the help of the U.S. Navy.

The J.O.S.F.C. has 23 permitted reefs, and maintains a buoy on each site throughout the year. Each reef is permitted to have a diameter of 2000 feet and a height sufficient to provide 50 feet clearance at MLW.

Current efforts are being made to make our reef program self-sufficient. We hope to work out an agreement with the new tire outlets to have them pay $25/ton to dispose of scrap tires. We feel this revenue would allow us to hire the persons necessary to keep our reef project viable. I personally feel that if we depend on Federal/State revenue to finance any reef program, it will ultimately fail. Consequently, I am determined to see that the private sector of our community carry the responsibility.

Dr. Charles E. Schutt is President, Offshore Sportsfishing Club, Jacksonville, Florida.

BARINC-BROWARD COUNTY ARTIFICIAL REEF, INC.

Gregory McIntosh, Jr.

BARINC, acronym for Broward County Artificial Reef, Incorporated, was organized in 1968 by a nucleus of dedicated fishermen and environmentalists to improve fishing in the oceanic waters off Broward County, Florida. The initial site selections were based on recommendations of experienced and equally enthusiastic faculty members of Florida Atlantic University, Boca Raton, Florida. The siting criteria were (1) to consider the run capability and accessability of the proposed reef(s) for small craft and customary tackle, and (2) to locate the reef(s) in waters of 60 - 125 feet depth, with hard sandy bottom which are the normal habitat areas for sailfish, the target species.

BARINC is a tax exempt corporation which is advantageous from a contribution or endowment standpoint. Considerable support also has come from local and state agencies. Local taxidermists, marinas and tourist attraction centers have contributed and even charter-boat fishermen participated when the objectives of BARINC were explained. Private manufactures contributed expertise and material.

Initially, BARINC relied upon voluntary labor and boat time. The Broward County Commission agreed that the disposition of solid wastes and the objections to land fills and incinerators could be accomodated by using the artificial reef concept. Sea dumping, under controlled conditions, offered obvious advantages for solid waste disposal. Broward County now expends some $80,000 - 150,000 annually in reef material disposal efforts, mainly tires. An initial attempt at assessing a 25 cent per tire levy on tire donors proved unsuccessful. We are currently awaiting decision by the Commission, regarding a possible grant from the Florida Department of Natural Resources. Other entities that assisted were the Coast Guard Reserve and Naval Reserve. Income or physical assistance actually comes from some 12 different sources.

While tires are the most commonly used materials, BARINC has used cement and ferrous rubble as well. On occasion the total loaded barge was sunk as a unit. Two derelict ships are also in place, providing excellent habitat for grouper and amberjack.

Mr. McIntosh, Jr. is vice-president, Ocean Research and Survey Co., Ft. Lauderdale, Florida, and past president, BARINC, and former chairman, Broward County Pollution Board. He is presently Project Administrator for the Nova University Ocean Sciences Center Artificial Reef Project.

PALM BEACH COUNTY ARTIFICIAL REEF

Marjorie R. Gordon

I am involved with a group that started the oldest officially permitted artificial reefs in Florida. In 1957 the West Palm Beach Fishing Club sought permission to construct a reef and discovered that the state had no permitting procedure. Patience and persistence rewarded the group and in 1959 a reef site south of the Lake Worth Inlet was approved. The West Palm Beach Fishing Club, the Palm Beach County Commission, the Wildlife Conservation League and the Jaycees constructed a reef with 309 cars and 200 pieces of white goods and outboard motors.

That is very difficult material to handle and some of it did not sink precisely on target. After 17 years there are a few automobile axles and other parts still providing a bit of low profile reef, but only in the years it is not sanded over.

In 1965 Hurricane Betsy grounded the Amaryllis, a 441' freighter, on a local beach. When, in 1967, it still had not been removed, the West Palm Beach Fishing Club moved to obtain it to start a new artificial reef. Again patience and persistence unsnarled the red tape. Consultation with the Bureau of Sport Fisheries found a site with a hard bottom and in 1968 three ships were sunk 3/4 mile north of the Lake Worth Inlet in 90' of water. First the 185' Mizpah found in a Tampa scrap yard, donated by an individual with fond memories of vacations aboard her, and towed to Palm Beach by a Bureau of Sport Fisheries research vessel. Next the Patrol Craft 1174 donated by the Sailfish Club and the winner of that year's International Women's Fishing Association tournaments. Finally the Amaryllis, by this time resembling a huge bathtub.

(Accompanying slides showed reef material construction and transport, fish recruitment and settling organisms.)

The three ships are in a north-south line and are a terrific fishing alley, also a great tackle collector. It was felt that widening the site would improve it but no one was certain if smaller materials would stay put. This reef site is probably the deepest inshore site in the state but it is subject to storm surges which have moved both the PC and Mizpah several feet. It has probably the highest average current crossing of any artificial reef in the country due to the proximity of the Gulfstream.

Ms. Marjorie Gordon is a member of the Artificial Reef Commission, Palm Beach, Florida.

With guidance from the Bureau of Sport Fisheries, in 1970 the Palm Beach Fin Divers scrounged materials and built 12 units of 7 tires strung on reinforcing rod, the bottom tire being cement filled. The divers monitored these units for a year and found they stayed where sunk, attracted fish and covered with settling organisms. I did the succession study of settling organisms, my husband Bob spearheadad construction and was appointed to the Palm Beach County Artificial Reef Committee. Success of the experimental units inspired the divers to a lot more scrounging and in 1971 they sank 1200 more weighted tires in units of 3 or as singles. All done at no cost and transported in small boats.

Also in 1971 the Reef Committee obtained donations of a tugboat and concrete rubble from a public dock being rebuilt. In the years since 2 barges have been sunk but the strong current carried them slightly north of the site. Most recently we have obtained the concrete rubble of a large bridge when it was replaced.

Each substrate shows some variation in settling organisms but whether it's high or low profile materials, fish abound. Not only are tropical reef fish there in abundance, but so are snapper, grouper, grunts and jacks, with occasional tuna and jewfish.

Local law designates this artificial reef site a preserve and nothing is taken from the reef except fish and then only with hook and line by trolling and drifting. It is a favorite site for divers and perhaps I shouldn't say "nothing" is taken from the reef, the divers collect a lot of fishing gear.

In summary, a great artificial reef can be built without money when there are a few motivated individuals leading and a lot of inspired scrounging.

REEF EXPERIENCES OF THE STUART SAILFISH CLUB

William W. Donaldson

The Stuart Sailfish Club is anxious to learn all it can about the latest recommended ways of building an artificial reef, expecially those which might be adaptable to the strong currents off the Martin County (Florida) shoreline.

Mr. Donaldson is currently an officer of the Stuart Sailfish Club, Stuart, Florida.

We also are anxious to learn if certain roadblocks are still being enforced to discourage reef construction, specifically the required $50.00 permit which we found necessary to allow us to dump two schoolbus bodies on our reef, and another $150.00 inspection fee to make sure that the bodies were clean. Wouldn't a permit form which listed all safeguards deemed necessary, signed and sworn to before some recognized public official and without any inspection fee suffice?

Transportation of reef-building material to the site from depositories on shore has been our greatest problem. Not only are suitably equipped barges difficult to locate, but the cost is discouraging. Has any thought been given to the State providing one and arranging a definite schedule of dates, when it would be available to service those reef-building communities?

Stuart Sailfish Club has the following report on the present status of its Edgar Ernst Artificial Tire Reef. This reef is composed of approximately 75,000 automobile and truck tires and two school bus bodies, and is located five miles east of the St. Lucie Inlet, in 60-ft. of water. Our reef is appropriately named in honor of Dr. Edgar Ernst, former president of the club and father of the reef and who supervised its earlier construction stages.

SCUBA divers from the Jensen Beach Campus of Florida Institute of Technology have photographed and identifies 37 species of fish on this reef. One significant difference in the appearance of the tires which comprise our reef, would be that each stand erect on the sandy bottom, due to the air trapped in their tops and the concrete ballast in their bottoms. This metbod tends to stabilize the tires and make them more resistive to strong underwater currents.

In the earlier stages of development, the weighted tires were individually "dunked" as they were thrown overboard from a slow moving barge. The 17,500 tires which were added to enlarge our reef in 1976, were wired together with heavy #9 galvanized wire and dropped in slings of ten tires each. This was done in an attempt to organize communities of habitats and provide more desirable height to the installation.

Through the enthusiastic cooperation of the local press, radio, and television, citizens of Martin County have been convinced that construction of artificial tire reefs pays far greater dividends in the production of protein than the pollution which results when they are burned, or the building sites which would be lost if the tires were buried in land fills.

The elected administrators of Martin County have given us substantial help from the beginning by providing space for the assembly and preparation of the discarded tires. County men and equipment have transported the tires to a barge, which we had leased to carry them to the drop site.

Solicitation of funds to cover necessary expenses is of utmost importance. The Stuart Sailfish Club has found that annual membership dues and annual profits from their nationally famous Light Tackle Tournament and Small Boat Tournament, were inadequate to support a vigorous annual enlargement of its reef. A distinctive appeal for funds was designed and printed on 3" X 8 1/2" yellow bond paper. As a public service, all seven of our Martin County Banks have cooperated each year by enclosing one of these slips with each customer's bank statement for that month, free of charge. This form was reprinted, along with a covering story in the Stuart News at the time of the appeal. These slips with checks attached would flow in, not only from the local area, but also from almost every state east of the Mississippi, and several beyond. This is concrete evidence of the continued support of our Reef project, by our part-time "Snowbird" residents. Other communities might consider this method of seeking financial help.

Six years ago Dr. Ernst organized a group of retired recreational fishing enthusiasts who donated many hours to this community project which we all believed to be so worthy. It wasn't long before our supply of cast-off tires increased beyond the capacity of these elders to process, and I was asked to recruit more volunteers. We soon discovered a vast number of civic-minded, local and seasonal residents within the Stuart area who yearned to supplement their golf and fishing time, with the companionship of other men of equal fishing interests. Each new recruit was encouraged to bring a friend, and it soon became a fraternity of about 125 individuals from all over eastern United States and from all walks of life; former officers and career personnel from the armed forces, lawyers, doctors, dentists, industrialists, business men, farmers, laborers and even former politicians decided that it was better to wear out, rather than to rust out. These men looked forward to the call which would bring nearly half of them out on short notice, to sort and fill the lower part of each tire with concrete ballast, in preparation for the next addition to the reef.

Group and individual recognition was attempted. One group from a mobile home part boasted of up to a dozen volunteers. Other smaller groups came in from Hobe Sound and even from Port St. Lucie in a neighboring County.

The selfless way in which these groups have responded to the call for service on this important community project, has resulted in the coining of a new word. Each and every one is thrilled to be referred to as a "Reeftiree". (The presentation features a series of slides showing preparation of the reef materials, methods of dumping, types and densities of fish attracted, and the volunteer Stuart Sailfish Club participants).

WEST FLORIDA'S REEF CONSTRUCTION EXPERIENCE

Joy Dunlap

Many of the communities in Northwest Florida are primarily economically reliant upon sport and commercial fishing support. Destin is an excellent example where local fishermen fish commercially part-time and augment their incomes by operating charter services for sport fishermen during other seasons. An October Fishing Derby, has been sponsored by the local citizens and has now become established nationally.

The local species feature both bottom and pelagic fishes, with grouper and king mackerel being the bread and butter species. Due to natural and man-made conditions there has been a gradual decline these past 7 to 8 years in the abundance of many of the main stay species. A County Waterway Advisory Board was organized through local effort in an attempt to identify the causes and devise means of ameliorating or overcoming the decline. Artificial reefs became the first candidate for consideration.

Earlier, and crude, efforts utilizing rubble, car bodies, tires and other scrap had been experimented with but with no systematics or noticeable results. The concept of a "tinker-toy" assembly, utilizing PVC pipe appeared to be economically, physically, environmentally and biologically feasible. Available literature indicated success in other areas of the world with this type of structure and one physical advantage, the ability to adjust placement via a buoy system, became obvious.

Essentially the structure consists of vertical PVC pipes with concrete baseboards consisting of concrete flue pipe with the core filled with cement. For stability retention the uprights are interlaced with horizontal PVC. Five foot sections are used. The number of couplings depends upon the water depth, keeping in mind the requirement for a 50' surface clearance for marine navigational safety. Aircraft stainless steel wire is attached and the height can be adjusted accordingly. The sections are then carried to sea and secured on-site. The 4 corners of a mile were marked off, and a boat was positioned at each, and as a mile run was made a structure was rolled off every 22 seconds, 700 sections in one square mile perimeter.

Captain Dunlap (USAF ret.) is a member of the Florida Boating Council, a licensed charter boat captain and guide, and co-owns a custom tackle shop in Destin, Florida.

We have also tried the Liberty ship route through the cooperation of the Florida Department of Natural Resources. Our first is sunk 5 miles offshore. Rubble, abandoned ships (oil free) and barges, tires, even an old bridge span have been used under supervised and planned placement.

Underwater observations confirm that these structures all serve as fish attractors but insufficient time has elapsed for any substantial marine algael growth or any reliable fish population monitoring.

As a small community our physical and financial resources are necessarily limited. Our group is planning to seek state and/or federal support in the forms of financial support, raw material procurement, use of material transport, and technical assistance.

(A slide presentation follows which shows the local geography, coastline, typical chart or commercial boat, principal species, prototype and actual placement procedures).

MARCO ISLAND'S (FLORIDA) ARTIFICIAL FISHING REEFS

Charles M. Courtney

The near-shore Gulf of Mexico bottom topography is characterized by a wide shelf which is possessed of relatively few rocky outcroppings, and is made up of predominately quartz sand sediment out to a depth of 60 feet. Water temperatures in the study area have ranged from 12 to 31°C. Marco Island represents one of the last in a series of barrier islands which form the Central Barrier Coast of Florida. Two nearshore artificial reef sites were chosen by the M.A.M.E.S. because of their proximity to major avenues of small boat and detrital movement, and to put improvements within the range of small boat fishermen.

Hard substrate based communities of sessile marine invertebrates do not occur naturally in significant quantities on the floor of the Gulf of Mexico off Marco Island. Where they are present, however, they do provide shelter and forage for a wide variety of marine

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Mr. Courtney is Director, Marco Applied Ecology Station, Marco Island, Florida.

organisms. The sites selected were latitudinally distinct in relation to the two major tidal passes and the types and concentrations of substrate materials emplaced at each. Reef #1 (a tire bundle reef) had 20 foot depth, broken shell and sand substrate, and an average visibility of 4 - 6 feet. Construction began April, 1972.

Bulk shipments of approximately 1000 tires of all kinds were received at the Deltona Corporation's construction compound on Caxambas Pass. It took a crew of two men approximately ten minutes to punch air release holes in 12 tire casings and to compress and bale the casings into a 3 ft. X 3 ft. tire bundle. Four strips of the Signode "Dymax" banding were used to hold the compressed casings in the bundle configuration. After approximately 200 bundles had been prepared in the aforementioned manner, the next stage involved the use of a cherry picker crane, standard cement pouring bucket, and a cement work crew of three men to fill the inside of each standing bundle with 1/20th cubic yard of concrete.

The tire bundles were then moved by a crane to an 80 X 30 foot work barge. Initially the barge was allowed to drift while bundles were randomly rolled off the barge by hand. SCUBA surveys of drop zones, however, revealed that bundles were being scattered over too wide a bottom area. The dumping procedure was modified to limit this scattering by using a specially designed, bow mounted, hinged bucket on the derrick barge. Up to 200 tire bundles could then be dropped in compact clusters (often stacked two high). Over 5549 bundles (66,588 tires) have been installed of Reef 1 at a conservatively estimated cost of $1.00 per tire.

Reef #2 (a rubble reef) had 30 foot depth, broken shell and sand substrate, but an average visibility of 6 - 8 feet. This construction began June, 1973. The Deltona Corporation continually accumulated concrete rubble, used trucks, cranes, etc. and these were loaded by cherry-picker onto the derrick barge. Drop zones covered the areas of the reef directly adjacent to each of the corner buoys. At the NW corner 4320 tons of concrete rubble and debris were deposited; the NE corner contained two 20 foot X 40 ft. halves of an old work barge, a cement truck, two crane booms and 30 tons of scrap metal; the SE corner had over 20,000 ft. of 18 ft. X 14 in. dredge pipe and 380 tons of scrap metal. By 1975 the construction phase at this reef site was completed.

SCUBA was utilized in approximately 100 hours diving on both reefs combined, to monitor the fish concentrations. However, poor visibility prohibited a planned standardization of methodology for each diving trip. Random diving was resorted to after many attempts at systematic transect diving. On each dive, parties of from 2 - 5 divers randomly surveyed individual drop zones and logged all sightings.

Within weeks after the first bundle drop on the 20 foot site the tire surfaces were colonized by barnacles and a wide variety of tunicates. The growth on the thirty-foot reef also started with barnacles, but with a greater relative distribution of hydrozoans and octocorallians than the inner reef site. Clupeid and Pomadaysid species dominated the initial fish fauna at both sides. Large schools of scaled sardine and yellowfin menhaden were noted at the surface and just over the materials on both sites. The Tomtate was one of the first resident species on either reef and was frequently observed on all survey dives. Porkfish and white grunt were noted in sizes ranging from 10 to 15 millimeters in length.

The gray snapper was one of the early residents and could be found routinely on either reef in a wide range of sizes. Lane snapper appeared on the 20 foot reef after several months and although few adults above 200 mm have been observed, juveniles were found down to 10 - 15 mm in and around both reefs.

Sheepshead were most abundant on both reefs during the winter and early spring when bottom temperatures reached the 67 - 69° F. range. Spadefish frequently occurred in large schools on both sites and along buoy chains. Crevalle jacks were routinely noted on the reefs often in large schools on the 30 foot site.

The smaller forage species, in particular, belted sandfish and spotted soapfish were noted utilizing the reef structures exclusively and were only rarely sighted away from this cover. During close examination of the tire bundles on the 20 foot reef small individuals of the families Blennidae and Gobiidae could be seen through the crevasses and gaps in the structures.

In dives on the bundle plots it appeared that the more densely compacted a drop zone, the larger the numbers of fishes attracted. The members of the Serranid family were particularly more abundant. Large jewfish (often exceeding 100 lbs.), red and gag grouper, and black sea bass were only observed on these dense plots. The first observations of large schooling snook were made on one of the 500 bundle drop zones.

The concrete rubble drop zone on the 30 foot reef provided greater depth, better visibility, a higher bottom profile, which, coupled with further distance from shore, tended to attract more pelagic species. Numerous observations of large jewfish, grouper, schooling snook and large numbers of gray snapper were made at this site. In November 1973, the first sightings of great barracuda (4 - 6 feet), greater amberjack and cobia were made above rubble. Species considered rare for southwest Florida included sand diver, palometa, yellowtail (down to 25 mm) snapper, sergeant major, hogfish and spotfin butterflyfish. It should also be noted that the reefs appear to be utilized extensively by the stone crab, Menippe mercenaria, a species which supports an important fishery in the southwest Florida area. The character of the rubble zone of the 30 foot reef made complete examination difficult but numerous stone crabs were found among the dredge pipe.

Some quantitative data was collected by regular fishing trips to the reef sites. Bottom fishing parties, 2 - 5 men each, used standard gear. Total fishing hours, numbers and kinds of fish creeled and total fish per man hour were recorded for each trip. Laboratory personnel logged 187 fishing hours on the 20 foot reef and 126 hours on the 30 foot reef for overall catch rates of 5.1 and 3.8 fishes per hour, respectively. The reported fishing success in the surrounding Ten Thousand Islands area averages a little over one fish per hour of fishing. Charter boats now frequently fish both reefs and some guides have already diversified their business by outfitting their boats to handle SCUBA diving trips to the reefs.

Conference Floor Discussions

(Ed. note: In his opening remarks, Chairman Popenoe explained that provision was made in the conference for floor discussion to promote speaker-audience dialogue and encourage interaction and exchange of experiences and ideas. The following, with no reference to personal identities, represent a distillation of the more significant questions, responses and informal contributions.)

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Q. Please clarify the respective responsibility of Coast Guard and Environmental Protection Agency regarding required approval to sink vessels for reef building purposes.

A. The joint concurrence of CG, EPA and Corps of Engineers is required, each with different criteria.

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Q. Does this also apply to debris, piling, rubble, etc?

A. A permit is required from DER and the Corps. EPA and Coast Guard would be notified by the Corp and the review and comments requested.

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Q. Now that DNR and the Corps adopted a unified permit form why can't EPA and Coast Guard follow suit? Why not utilize an application acceptable to all four agencies?

A. Three different federal laws are involved, (River and Harbor Act, Marine Sanctuary Act, and Federal Water Pollution Control Act). Congressional action would be required.

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Q. How far does the State jurisdiction extend and how is shoreline defined?

A. Three miles in the Atlantic and three marine leagues (approx. 10 miles) in the Gulf waters off Florida and Texas, 3 miles off all other states. If dumping occurs beyond this limit, only Federal laws are applicable. The 3 marine league measure represents Supreme Court acknowledgement of the original Spanish claim prior to purchase from Spain.

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Q. Could Florida Sea Grant provide samples of, and instructions for filing the various Federal and State permit forms and application instructions?

A. Sea Grant plans to issue Marine Advisory Publications to this effect. Also, references to the involved agencies will appear in the printed proceedings of this Conference.

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Q. Could this be carried one step further? Could Sea Grant provide an expert or a group to meet with local interest groups and provide technical assistance?

A. Yes, if it is the concensus of this Conference that there is a need for this type of consulting service. (Ed. note: A Sea Grant award has subsequently been let to St. Petersburg Community College to provide reef siting, engineering and procedural assistance. Also, the Marine Advisory Program has trained its staff on this subject to service Florida users.)

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Q. Our past experience has been that the application forms and time requirements are cumbersome and time consuming. Can the respective agencies streamline their procedures?

A. This is an acknowledged problem and remedial steps are being studied by the Corps and DER. Some resolution is expected shortly. (Ed. note: Effective July 1, 1977, the two agencies developed a joint application form to be filed with the Corps, a copy going to DER for simultaneous review. Federal statutes require a 30 day public notice minimum by the Corps but the review process is being streamlined to reduce review time. DER has now delegated local approval authority to its field offices to expedite permit issuance.)

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Q. Can a sportfishing club, interested in obtaining multiple permits, obtain exemption from the $100.00 commercial filing license and qualify under the $10.00 non-commercial category? It makes quite a dollar difference and can discourage lesser-financed clubs to enter the reef support program.

A. Exemptions can be made under such unusual circumstances. The Corps can establish discretionary group fees but individual site permits and applications will still be required. This is applicable only when non-commercial situations exist and must be treated on individual case basis.

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Q. Please clarify the permit lapse features involved in the three (3) year construction period allowed successful applicants and the request for the (10) year maintenance dredging and filling. A six month stop period could disrupt a club's schedule, involve costly storage problems, and create on-shore environmental hazards.

A. To clarify, the initial permit issued by the Corps is for a three (3) year period. Assume that the applicant wishes to maintain and replenish the reef. The Corps requires such notification, will evaluate it for conformance to original permit and adherence to maintenance requirements, and ascertain if the original construction created any public problems. Only requests for ten (10) years extension intentions will be entertained. Barring problems in the evaluation, no time lapse would occur. If however, the applicant merely wants an extension of the three (3) year construction permit, with no ten year maintenance, this can be granted. In rare cases, a six (6) month extension will be involved where the original permit is about to lapse and the permittee belatedly decides to go for the ten year maintenance permit. Advance planning can eliminate this latter type of situation.

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Q. Does the State of Florida support any grant-funding for artificial reefs?

A. The Division of Parks and Recreation has made some grant funding.

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A. What form of interaction exists between the Florida Division of Archives and the various archeological societies to publicize archeological sites and avoid illegal digging, construction, or intrusion?

A. The greatest threat comes from an uninformed public and the State agency wants to enhance interaction with amateur and professional groups and societies. Also, this pool of expertise could be drawn upon to perform certain survey work on a volunteer or reimbursement basis.

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Q. Has Sea Grant, or the state, considered the possibility of supporting a mobile barge operation that could be available to local groups for reef material transport that is now beyond their present financial means to operate? Frequently there are non-recurring needs in any one locality but on a state-wide basis such a mobile barge could be in steady demand by small groups around the state.

A. This is out of the purview of Sea Grant and the state has no funds available. Perhaps this is an opportunity for some enterprising individual or group in the private sector.

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Q. Is there a national clearing house for artificial reef information or technical advice?

A. The NMFS supported such a clearing house until its program was terminated in 1974. However, that agency can still serve informally in that capacity.

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Q. Has the commercial fishing industry, through its trade associations, attempted to educate state and local legislators on the value of reefs and, secondly, do any funds appear to be forthcoming in the state budget for reefs?

A. Enlightening public officials on marine affairs is a continuous function of the industry. The political process is important. (Ed. note: Legislation has been proposed to the Congress, January 1978, to provide for funding reef construction.)

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Q. What is the hydraulic pressure used on the tire compactor? Is there substantial danger in handling such a compact bundle?

A. Sixty (60) tons. Concerning hazard, the 150 tires have 5 bands. When cut from one end toward the other there has been no problem. Caution, stand on the side when severing the bands, not in front of the bale.

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Q. Regarding the South Carolina suspended system, are the tires slashed or is there some normal air retention? Can you provide informational experiences on setting and losses?

A. For ease of transportation, the tires are automatically slashed across the tread at 80^{o} and the steel cable is threaded through the opposing slashes. There is no air retained. Rather than retrieve units, or use PVC floats, we engineered the gear so that the cable and attachments would sink to the bottom and become part of the benthic reef. We find that future deployment will be enhanced by setting up parallel alleys, 300 feet apart, to provide better turning radius and retrack. We now recommend five hundred (500) pound sinkers.

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Q. Again to South Carolina: Please explain the difference between the surface and the freon float. Would the float be required if the tires were not slashed?

A. The South Carolina permit allows twenty (20) foot clearance even though the closer to the surface the better. There really is no hazard to deep draft craft, but the Corps' position was firm about this. The freon floats are required, even without slashing the tires, as the air would soon be absorbed. Possibly strong wave action areas might provide longer air entrapment.

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Q. Have underwater observations on the vertical structures, PVC or tires, provided any evidence of species stratification or species selectivity?

A. Not in the Mississippi vertical structures. In South Carolina we noted a benthic type situation on the sinker. The bait fish were at, or near, the surface, with outer perimeter predators. The feeding frenzy drove the bait inward and downward.

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Q. How does one prevent spear fishermen from taking over a reef?

A. Politically, a preserve can be established for the spear fishermen separate from the hook and line areas. This requires negotiation between the groups. We do not endorse such severe action as the deliberate drawing of sharks to an area by the dumping of bloody carcasses from line boats to discourage divers. Also, free diving on reefs should be differentiated from scuba diving.

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Q. How did Dr. Hanni arrive at the two (2) cents per tire cost? Since public lands, equipment and services were involved do you consider your results to be valid?

A. The local County budget data were used as well as the same imputational method for other below market price, or free, items and services. This with tonnage used gave the two (2) cent figure. Other speakers have referred to donated materials, services, time, etc. Yes, I consider the results valid.

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Q. Buoy maintenance is a problem. Once a permit has been granted, can this responsibility be abrogated?

A. The Coast Guard has the responsibility for enforcement and monitoring. A Coast Guard waiver, under certain mitigating circumstances and only then after an initial one year of monitored compliance, is possible but not too frequent. If the buoys are in a shipping lane such waiver is almost non-existent.

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Q. Does this apply even where there is as much as forty-five (45) feet clearance? That doesn't seem realistic. Shouldn't each case be judged on its own merit? Some misdirected vandals deliberately cut buoy markers. These are expensive and time consuming to replace.

A. Our experience has been that Coast Guard maintains a pretty stiff position on this. They will provide some leniency as far as replacement time is concerned if a need exists. Also, if you cooperated by giving earliest possible alert to the Coast Guard, it will facilitate their publication of "Notice to Mariners" which does relieve some liability.

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(In addition to the Questions and Answers there were numerous comments from the floor concerning the conference subject matter generally. Any error in substance or interpretation by the editor during the transcription - proceedings transfer process should be pardoned.)

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Comment- The commercial fishermen can be very helpful in indicating locations of snags that prevent commercial dragging but do have potential for the nucleus for future reef development. Also, there are commercial, state, and Sea Grant publications available which could be of help to groups looking for a starting place. Also, the day of state or federal reef support for commercial operations may be approaching. Other countries, notably Japan, are already heavily involved in this type of commercial crop endeavor.

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Comment- The state has had access opportunity to derelict ships, ideal for reef purposes, but no funds to support the necessary canabalizing to reduce pollutants, such as oil tank or other contaminant cleansing. Local citizen vocalizing could influence legislator interest. Florida does have a Liberty ship program but ships and canabalizing funds are limited.

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Comment- Why depend upon public funds? Users should pay their own way the way fresh-water fishermen and hunters do - through a license fee system whereby the bulk of the revenue so derived is specifically allocated for habitat improvement efforts. A salt-water licensing system could be developed for this and similar stock and habitat improvement programs.

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Comment- North Carolina initiated a tax-use program in 1962 or 1963. Certain of the state gas tax revenues from marine fuel sales were allocated for boat ramps and artificial reef development. It approximated $260,000 a year. This originated from local user pressure and education of the state legislators.

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Comment- Certain boat registration fees are returned to the counties for local disbursement. Reefs, apparently, have not benefitted to date in this program, as most of the dollars have gone for boat ramps. Perhaps Statute 371 could be amended to so provide.

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Comment- Our group is proposing a twenty-five (25) cents tire tax disposal to be assessed at point of sale and new-used tire exchange. Tires have to be disposed with local trash collection funds being involved. Millions of tires are a burden that can be converted to an asset. A 25 centscharge on a $25-75 dollar tire won't hurt the buyer.

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Comment- A problem arises in South Florida as far as use of the South Carolina rig is concerned inasmuch as we have a deeper littoral slope and the forty (40) foot curve is near the beach. The currents also are unusually strong. Therefore, a twenty (20) foot clearance clearly represents a hazard to commercial and other deep draft craft. Perhaps a weak link system would reduce the propeller entanglement problem.

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Comment- Our reef is unusually productive and catches are easy. A problem is the congregation of snook, a legislatively declared game fish and an illegal fish as far as commercial capture and sale is concerned. We have both gravid and non-spawning populations, depending upon season. Surface lures, used at night, are being used by marine based pleasure and charter craft with unfairly large catches. This seems unfair and should be outlawed in the interest of protecting this species.

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Comment- This conference has certainly highlighted the need for further reef research on the biological characteristics and properties of reefs, both natural and artificial. Do reefs serve as magnets? Are they self-propogating? Is there spawning on the reefs; if so, which species, the comparative survival of larvae and juveniles.

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Comment- The responsibility for buoy maintenance cannot be overstressed. Initial enthuslasm soon succumbs to the arduous and repetitious labor requirements. This neglect can give all projects a black eye.

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Comment- Coast Guard recently decided to remove reef buoys from their light lists and charts. They will indicate there is a fish haven in the area, but not indicate buoys. We consider this a mistake and have so complained to Coast Guard. However, Washington maintained the Coast Guard decision. We advocate an organized campaign by the recreational groups to reverse this decision.

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Comment- One opportunity for funding has not been covered specifically, which is the Dingle-Johnson Act. This Act provides funds, where licensing procedures are in effect, for a myriad of aquatic activities. The upland people have used D-J funds since its inception as have the fresh-water boaters and fishermen. While opinions differ on the merits of D-J, the fact remains that Florida's salt-water fishermen receive no funding support by virtue of the lack of a salt-water fishing license. There will be great diversity of reaction - why assess the small fellow; why tax the one or two day fishing tourist; why assess the one day fisherman on a charter or head boat; shouldn't the boat operator pay the fee; why tax divers; who will enforce the license requirements; why tax the bridge fishermen; will administrative costs outweigh benefits; who determines fund use and for what projects; how are priorities established? But all of this should be placed in proper perspective. We have pleaded the case for funds - here is an opportunity. It does come at the cost of licensing.

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Comment- All of the research relating to reefs in Georgia comes from D-J funds. The state has the responsibility for its administration. It would be up to the people in Tallahassee.

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CONFERENCE SUMMARY

Hugh L. Popenoe

In evaluating the presentations and general discussions of this two-day Conference in the light of our original objectives, I think it is fair to say that the project has exceeded our original expectations. Not only were the papers of high quality but they adhered to the agenda structure originally intended. The floor discussions significantly added to the papers and the free exchange of information contributed substantially to the experience and expertise of all who attended. I gather from the spirit of the Conference that it was well received and, on behalf of the Florida Sea Grant College, I want to express our heartfelt appreciation for your participation.

I want to particularly acknowledge the contribution of the Session Chairmen, each of whom is recognized as a specialist, who so skillfully organized their sessions, adhered to the time and subject format, and contributed to the effective meshing of the Conference. The audience and reader of these proceedings should know that several of them surrendered their eligibility to present formal papers, for which they are imminently qualified, to serve in the capacity of session chairmen.

Several conclusions, specific and general, can be drawn from these past two days. Several problem areas have been identified and researcher, administrator, and user needs expressed. It is obvious that this is a growing area of user interest, and that there is considerable experience and expertise available to guide these users, albeit there is a demonstrated need for increased emphasis at all levels if we in science, education, public administration and private endeavors are to satisfy the growing needs of our marine constituency.

We discussed the general concepts of reef site selection and engineering, permitting procedures, the biological, social, economic and engineering aspects of reef operations and benefits, the broad range of users and compatibility issues involved, the funding of reefs, and case studies of reefs not only in Florida but in adjoining states.

In identifying areas for future actions there is obvious agreement in certain areas.

Dr. Hugh L. Popenoe, Conference Chairman

(1) There is a demonstrated need for improved permitting procedures. Remedial steps suggested were: The use of a common format by the involved agencies; speeding up the process; and more specific filing instructions. The need for more advisory bulletins by these and related agencies was emphasized;

(2) The need for a statewide atlas of natural and artificial reefs was expressed and Florida Sea Grant is prepared to address this matter;

(3) The organization of a task force to work with local groups to survey existing and potential reef sites and advise on engineering techniques was recommended. Again, Sea Grant plans to respond;

(4) There is need for more advisory services, including publications, personal contacts, workshops and conferences. Florida Sea Grant, through its statewide Marine Advisory Program network, will become more involved and the opportunities for other agency and institutional involvement are broad in this field;

(5) Certain legislative needs were expressed; for instance, the use of motor fuel taxes for marine facility development and the controversial matter of a salt-water fishing license which, on the one hand might free Dingel -Johnson funds for marine recreational development and on the other bring strong negative user reaction. These are political issues that have considerable impact on agencies with management responsibilities;

(6) The need for a common property materials handling barge, probably State funded, to assist local groups was expressed. This is an area the Florida Department of Natural Resources might opt to explore;

(7) The need for expanded ecological studies was stressed throughout the Conference. Each marine oriented public and private agency and institution has the challenge to respond;

(8) There was encouraging and apparently general support for additional conferences on natural and artificial reefs. Florida Sea Grant stands ready to respond at the state or regional level and will canvass this and other groups and individuals early in 1978 to ascertain general reaction to this proposal.

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The Conference was adjourned 5:00 p.m., Saturday, June 11, 1977.

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