Visual Resource Management of the Sea[1]

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Abstract: The scenic quality of the marine environment has become an important concern for the design and planning professions. Increased public use of the underwater environment has resulted from technological advancements in SCUBA, recreational submarines and through development of underwater restaurants and parks. This paper presents an approach to an underwater visual resource assessment with a case study example of St. Croix, U.S. Virgin Islands. Key seascape dimensions discussed are: water clarity, color, topographic relief, water depth, marine life and historic values. This assessment system provides a mechanism for the inclusion of scenic values in marine resource and planning inventories.

INTRODUCTION

The scenic quality of the sea has attracted mankind's interest from ancient times. Until the 20th century, the undersea environment has been dealt with, by the majority of people, only in fantasy works from Jules Verne and other imaginative authors, fisherman or naval experts. As a result of inventions such as SCUBA gear, submarines, off-shore drilling rigs and ocean mining apparatus, the marine environment has become an active arena for man's expansion and exploitation for resource recovery, recreation and even habitations.

Visual resource management of land and coastal environments has received extensive planning and design research. The management of the visual resources of the marine environment has been a rare topic. It is only as recently as 1943 that practical SCUBA gear was developed by Jacques Cousteau and Emil Gagnon and not until the 1960's that the first underwater trail/marine park in St John was designed and constructed (Figure 1*). Presently, such ventures as underwater observations/restaurants have been constructed. The development of submarines for military and research purposes was initiated during the Civil War. Limited recreational usage of submarines was begun with "Theme Parks" in the 1960's. It is not beyond reasonable belief that extensive recreational use of submarines will occur be-yond the "Disneyland" level. Such increased use of the marine environment demands that attention to the change and management of the visual resources be addressed.

ADVANCES IN AQUATIC TECHNOLOGY

Historically, there were three motivations for exploring the undersea environment: for food, for treasure and for military operations (Larson 1959). Presently, recreational and environmental aspects have become major attractions for marine travels. It is reported that in 1575, Alexander the Great descended to the ocean bottom in a diving bell. Until 1771, the diving bell was the sole apparatus for penetrating the undersea world. After 1771, man was a diver, as opposed to a swimmer, with the development of helmet/hose diving apparatus. With this equipment, connection to surface operations was mandatory for the man in the sea. In 1876, Henry Furness, a British mining engineer, developed a self-contained, close-circuit, underwater breathing apparatus (SCUBA). During World War I, a major use of the device was by the military in submarine warfare. In 1918, the first reported sinking of a ship from the British Navy by Italian divers occurred.

The publication of Jules Verne's <u>Twenty</u>

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*See color illustration on page 399.

Thousand Leagues Under the Sea stimulated much public interest in the marine environment. In fact, in 1915, Verne's book became the subject of the first underwater motion picture, shot by J.E. Williamson (Larson 1959). In 1912, the first recreational reference to diving appeared in print in relation to a submarine sled, "....the advent of a new sport, that of submarine travel, may be forseen for the very near future" (Davis 1912). But it was not until the development of Cousteau and Gagnon's open-circuit SCUBA device in 1943, that extensive recreational use of the undersea environment occurred.

As the public use of the marine environment geometrically expanded in the 1950's and 1960's, pressure for establishment of marine preserves increased. Concentration of divers, fishing operations and other human activities in particular areas caused a deterioration in the quality and diversity of marine and benthic organisms. Collection of shells and coral, spearfishing and capture of tropical fish for aquariums overloaded the replacement ability in certain marine areas. This encouraged public statutes to protect the marine life and environment for certain pristine areas.

MARINE PARKS AND HABITATS

In 1960, at Point Lobos, California, on the Monterey Bay, the first marine state preserve was established. Shortly thereafter, President Kennedy gave federal protection to a marine area, Key Largo Coral Reef Preserve. The State of Florida, subsequently protected the nearshore area by establishing John Pennekamp Coral Reef State Park. From this point on, many states and other countries have established marine preserves and parks.

There appears to be two main types of marine parks: those with (1) sites having significant marine flora and fauna and (2) historic sites (Wamer 1978). The major purpose of these parks has been conservation. Lately, there has been an emphasis on recreational development. For example, the Trunk Bay Underwater Nature trail off St. John encouraged active public participation in the underwater world. Continual advancements in SCUBA gear have allowed mass involvement in the marine environment.

In 1962, Edwin Link in the Man-In-Sea Program initiated underwater living habitats with a one-day stay in the Mediterranean Sea. In 1969 and 1970, more publicized efforts were the two TEKTITE experiments at Lameshur Bay, U.S. Virgin Islands, lasting for 59 and 30 days respectively (NOAA 1975). As of 1975, approximately fifty undersea living habitat experiments have occurred worldwide.

With such developments, it is obvious that a new era of exploration of the sea has emerged. These projects demonstrate man's ability to penetrate the ocean and stay for prolonged periods beneath the sea.

While these types of projects were primarily environmental and exploratory, similar projects of a recreational or commercial venture occurred. In 1968, a proposal for an underwater restaurant was submitted in San Diego for a 200-capacity lounge. Other sites being considered were: Los Angeles, San Francisco, Seattle, the South and the Pacific Islands. In 1977, St. Thomas, U.S. Virgin Islands, became the site for the first underwater restaurant/observation lounge in the Americas (Figure 2*). Other existing restaurants are located in Israel (Elat), the Bahamas and Japan. The site selection process for such commercial ventures is an excellent example of visual resources management of the sea.

These projects demonstrate the commercial value of beautiful seascapes and the need for protection and provision of accessibility to scenic underwater worlds and indigenous marine life. Important factors considered in site selection were: (1) number, variety and appeal of biota, (2) visibility, (3) bottom topography, (4) subsurface geology, (5) bottom sediment, transport patterns and rates, (6) currents and waves and (7) effects of seasonal variation. Other factors that are essential to commercial viability are: access to shore, availability of food and lodging, and location in regard to population centers (Mar Consult, Inc. 1971).

The development of marine underwater parks in recent years throughout the world has focused attention on the quality of the visual environment of the sea. There appear to be five main purposes for these parks: (1) perpetuation of unique marine ecosystems, biological and geological features and significant historical objects or sites, (2) protection of specific forms of marine life and habitats, (3) research and educational study of undisturbed marine environment, (4) recreation and (5) buffer zones (Wallis 1971). The visual resources of these parks seem to be an integral factor for each purpose, along with a broad range of other variables.

In the selection of sites for underwater marine parks or restaurants, visual quality is a key factor, but has rarely been addressed directly. Cultural resources such as historical sites, wrecks, sunken cities and fishing spots are relatively easy to identify. Natural resource inventories usually identify factors such as climate, geology, limnology and biology. Scenic factors, on the other hand, are not as easily addressed.

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*See color illustration on page 399.

UNDERWATER VISUAL RESOURCE ASSESSMENT

Conceptually, methodolgies for assessing the visual quality of the marine environment must take on radically new dimensions. Consideration of the perceptual framework and setting via SCUBA, skin-diving gear, or submarines is essential to the assessment system developed and applied due to dramatically different experiences and "viewsheds." While movement through landscapes is easy on foot, by car or plane; movement through waterscapes requires artificial breathing systems as well as transport systems. Because of the technical limitations, rarely does one sit to contemplate the view underwater as on land. Furthermore, movement through the sea is slow as compared to land transportation. Thus, the way one views and perceives seascapes is in an entirely different realm and requires a radically different approach than on land.

In landscape visual resource analysis viewsheds are a primary consideration for any study area. What one sees from the road, on foot, or in the air is critical. We don't really care about what we can't see; conversely, we encourage the screening of the ugly with fences, structures, or vegetation.

The view in the sea is determined primarily by factors such as: water clarity, one's speed through the water, lighting (artificial and natural), mode of transport, topography and flora. The physics of underwater sight and color perception is only beginning to be addressed (Drew _et al_. 1976). The identification of "viewsheds" can be mapped similarly to land analysis methods.

Perhaps the most important factor to be included in an underwater visual assessment method is clarity. However, of all the previously mentioned factors, this has the most variety and variability. In most diving accounts or tales, the quality of the water clarity is immediately addressed. Recreational diving usually occurs only during periods of good clarity for a particular area and most diving activity is concentrated in areas with good-to-excellent water clarity. In general, the range of good clarity is from 15 to 300 feet. Reasonably, the management of the visual resources of the undersea environment would be limited to such areas with good-to-excellent clarity. Logically, management of water clarity must be closely tied in to management of land use activities, construction and water quality programs (land-based).

Relative to viewsheds, the management of clarity can be accomplished relatively easily by empirically measuring sight distances vertically and horizontally or determination of light transmissivity of the water medium using a transmissometer. However, understanding the factors responsible for water clarity is a complex phenomenon involving water depth, surface and bottom currents, wind and wave storm conditions, tides, temperature, salinity, water quality (pollutants), flora and fauna productivity, surface runoff and many other parameters (General Research Corp. 1970). For planning and design purposes, it is logical to determine the range and mean of water clarity during peak user periods.

A ramification of existing aquatic technology is the significantly reduced scale of viewsheds. Much smaller viewsheds are experienced and perceived in the sea than on land. One just does not get "breathtaking" panoramic views as on land. However, what is lost in scale is perhaps gained in detail.

Color in the seascape is another important variable of scenic character. As with most landscape visual analysis, this parameter is indirectly alluded to in a descriptive manner and rarely in a quantitative way. While the intensity of light is easily measured by a light meter, the perception of the light and color diversity is another complex topic beyond the scope of this paper (Drew _et al_. 1976). Similarly, underwater photography must be approached completely differently than land photography.

Topographic relief can be readily quantified and included in undersea scenic character and quality analysis (Zube, _et al_. 1974). While a descriptive summary of topography and related geologic formations is an important factor, a quantitative measure of topography is critical to visual analysis. Topographic relief can be measured in a similar way to land environments, from nautical charts, yet again formation and scale of sea forms are in a different perceptive realm. Exciting dive locations are often at areas of dramatic change in topographic relief. The smaller scale relationships underwater must be considered; unfortunately, many nautical charts are at too gross a scale to indicate dramatic small scale topographic changes.

Water depth, related to topographic relief is another important consideration. While depth _per se_ is not directly critical to scenic quality, indirectly it affects factors such as clarity, color penetration, flora and fauna. All underwater visual resource assessments should include depths of a study area because they relate directly to the kind of recreational use expected. In general the deeper one goes, the more critical and sophisticated are the life support systems required. Present day state-of-the-art recreational SCUBA is predominantly limited to less than 100 feet. Marine parks and restaurants have less of a threshold depth because of economic realities and linkage requirements to coastal areas.

Viewing the abundance and diversity of marine life is a primary incentive to go underwater. A factor that makes the seascape so unique is a very high concentration of marine life in certain areas as compared to that of life in most land habitats. A quantitative index for marine life both in number and type is useful in visual assessment. As with land fauna, there is a distinct nocturnal and diurnal change of behavior and activity in marine life. For this reason, night diving has become a popular recreational pursuit. Viewing marine life is easier than most wild land fauna types because one can approach much closer without inducing a fear flight response. However, in areas of high spear-fishing activity, there is a distinct increase in this response for certain fish types. For obvious reasons, spear-fishing and collecting marine life are excluded in scenic marine parks and preserves.

Historical values should also be considered in an assessment study. Diving activities are often in areas with shipwrecks, sunken cities or structures, and sometimes in ocean dump sites or artificial reefs. While the motivation is often to collect artifacts and salvage value, a large factor is the scenic value. In addition, underwater structures, such as wrecks, oil rigs, and even discarded tires provide shelter and habitat for a large variety of fish and other marine life.

Identification of historic sites and structures is sometimes easy, since many wrecks in coastal waters are usually placed on nautical charts for navigational purposes. However, there are often discrepancies on precise locations of sunken ships on charts. The natural forces of the ocean rapidly corrode, bury or break up wrecks, so that the scenic value for historic sites often deteriorates quickly over time. Quantification of scenic value for historic sites is highly subjective except for indicating the presence or absence of such an amenity. For a seascape visual assessment, site-specific identification of historic areas or wrecks is a key factor.

There are many other variables that relate to seascape quality. A visual assessment study must be tailored to the particular kind of planning project or design concept. As human activities in the sea increase, more scenic variables would be encountered. Presently, habitations in the sea are still in the design stage, other than in an experimental manner, but are a likely future event. Design review of marine structures for aesthetic reasons is not a far-fetched idea. Environmental impact statements presently address such topics indirectly.

Part of the difficulty with seascape visual analysis is that almost no research has been undertaken. As recently as 1975, an attempt at developing a classification system for coastal and marine environments was carried out as part of the UNESCO Man and Biosphere Program (Ray 1975). It is unrealistic to expect sophisticated seascape visual assessment techniques without more basic research in understanding marine habitats.

Prior to assessment, a clear set of definitions and terminology for the seascape must be developed as has been done with the landscape (Appleyard *et al*. 1978). Closely related is the development of design principles of the seascape. Factors such as distance, observer position, form, spatial definitions, light and sequence of view should be included. Without comprehensive definitions of terms covering a variety of environmental situations and scales, the planner or designer is handicapped in justifying evaluative judgement.

VISUAL QUALITY ASSESSMENT: A CASE STUDY

The visual quality of the marine environment of the U.S. Virgin Islands has long received international acclaim. *Skin Diver Magazine*, a leading diving publication, rates the waters for diving as "the most beautiful area in the world." It is not surprising that the Virgin Islands is the site for the first underwater trail, one of the first underwater parks in the world, and the first underwater restaurants in the Americas. On the other hand, dredging activities during construction of the largest oil refinery in the Americas (Hess Oil) decimated one of the most productive and largest mangrove lagoon areas in the Carribbean, and wiped out diving activities for half of the southern part of St. Croix. While substantial planning efforts have occurred in the Virgin Islands to protect the marine environment, deterioration of the pristine marine environment continues from factors of municipal sewage, industry, land development, fishing and recreational overload. For these reasons, improved management of the seascape is critical.

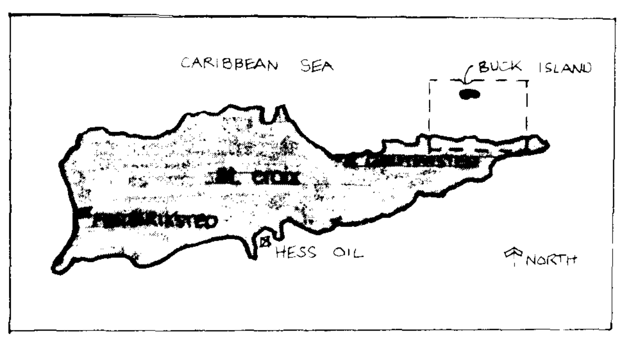
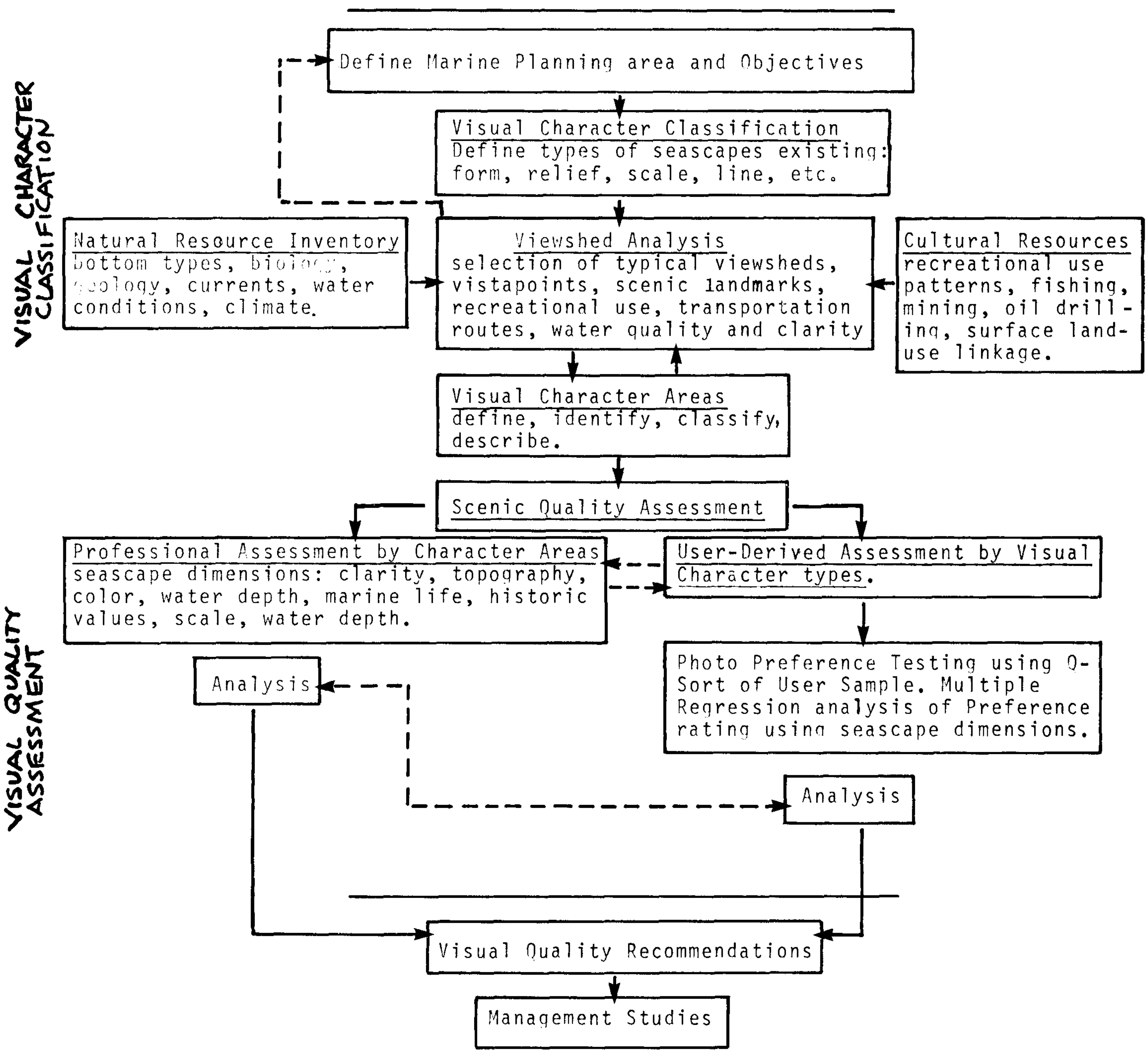


Figure 3--Site Location

Figure 4
SEASCAPE VISUAL RESOURCE ASSESSMENT



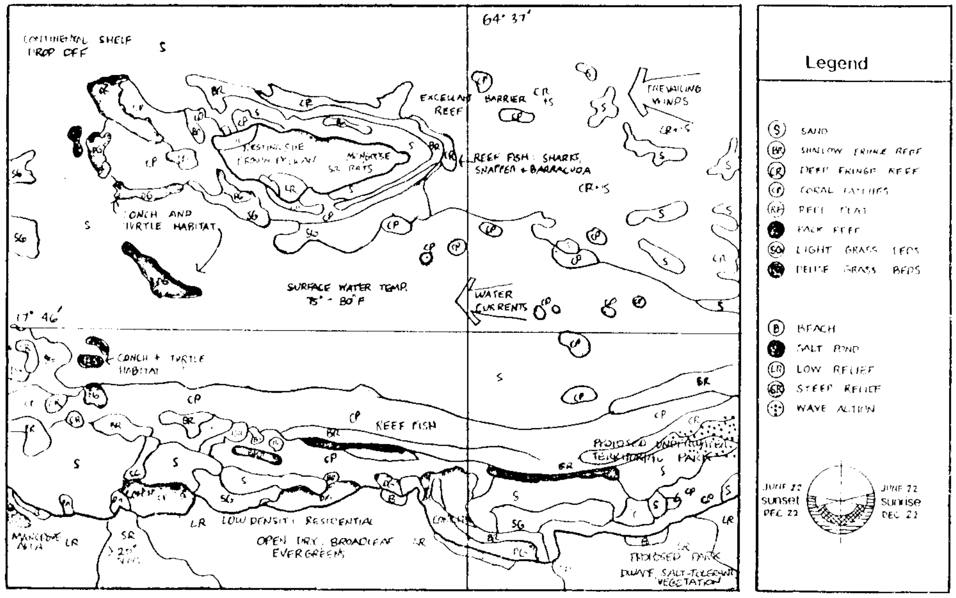


Figure 5--Land and Seascape Visual Resources

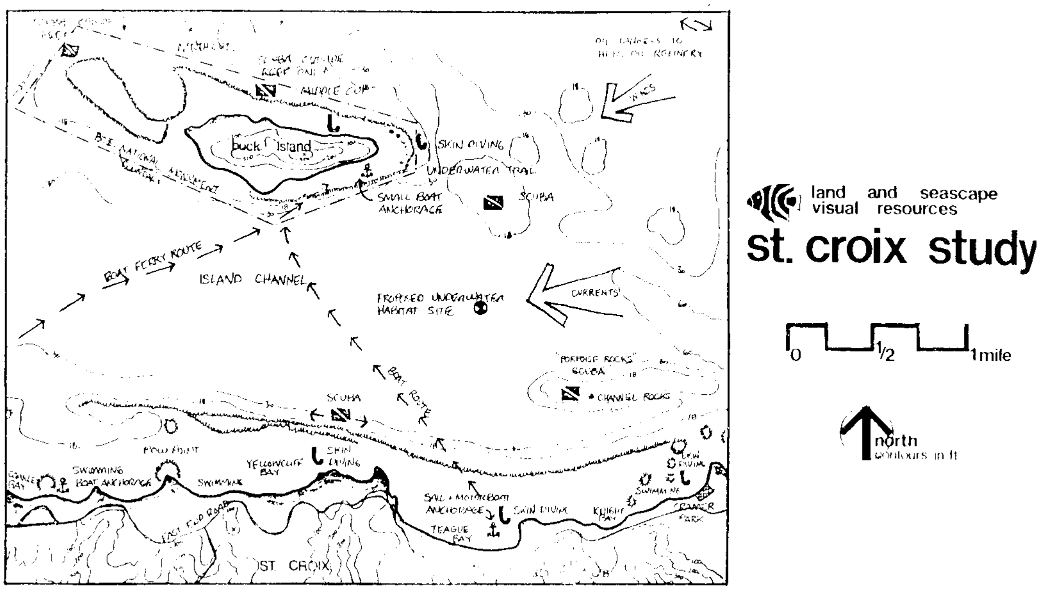


Figure 6--Natural Resources

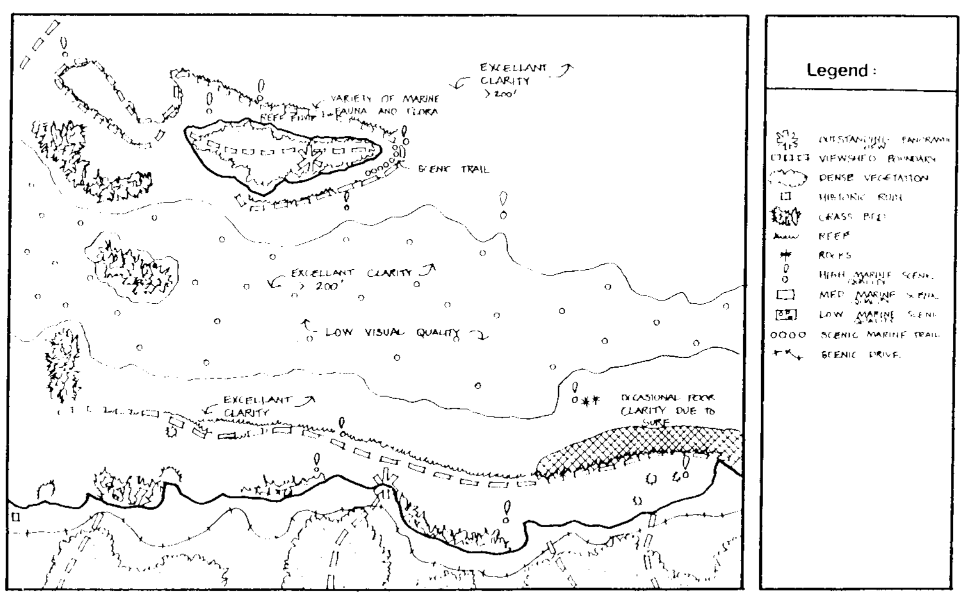


Figure 7--Recreational and Cultural Resources

The study area (see figure 3) includes part of the Buck Island National Monument (island and reef), a section of the north coast being considered for a marine park in the territorial park system and a research station of Fairleigh Dickinson University (West Indies Lab). The fringe reef along the north coast receives considerable recreational usage. The land and marine environment is still relatively pristine and could tolerate moderate development (another underwater park, underwater restaurant, etc.), if done in a manner sensitive to the fragile environment.

Figure 4 illustrates a methodology for visual resource analysis of the area and a means to incorporate the analysis in planning. There are three basic phases included: visual character classification, assessment and management. Because of time and funding, the management phase was not initiated in addition to the user-derived assessment.

Figure 5 presents a natural resource inventory. Data were collected from air photos interpretation, U.S.G.S. topographic maps, nautical charts, and my personal familiarity with the site as a member of the territorial Coastal Zone Management Staff. Unfortunately, no systematic site survey was undertaken to obtain "ground truth." The use of air photos is an invaluable planning tool for marine visual resource studies in areas less than 100 feet in depth. This study perhaps demonstrates the maximum limit for conventional air photos usage under existing technology because of the exceptional water clarity.

Recreational and cultural resources for the area are shown in figure 6. Diving information was collected through interviews with professional diving guides and marine biologists with the territorial Department of Conservation and Cultural affairs, in addition to my personal dives in the area. Strict management of Buck Island by the Park Service has kept it in pristine condition.

The visual resources analysis (fig. 7) combines both a visual character classification and quality assessment. The low visual rating (relative to the Virgin Islands) of the channel area is due to variability in topography, low diversity of marine habitats (mostly sand bottom) and low underwater recreational use. Conversely, areas of high quality were identified due to a combination of factors and high component value for water clarity, topographic relief, marine life, history and recreational use.

The assessment system is at a very gross scale of rating. A more precise rating would be ideal if user-derived values were available and basic research was completed in underwater perception of visual quality. With visual ratings, one can then assign priorities to planning and design objectives and implement a management program of protection, enhancement or rehabilitation for the area. In the case of St. Croix, preservation and strict management of all viable reefs and grassbeds is a primary objective, since these are the major visual resources of its marine environment.

CONCLUSION

The future use and management of the marine environment is wide open to the design and planning professions. While the scope of this paper has been on marine visual resource analysis, a significant and related factor not addressed is environmental quality. According to Jacques-Yves Cousteau: "...... We divers are witnessing the demise of the precious wilderness we discovered" (Cousteau 1978). While tremendous allocations of money have been applied to space research, marine research and development has been neglected. The realm of management of the visual environment of the sea is a new frontier.

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