DIVER-BASED UNDERWATER SURVEY TECHNIQUES USED TO ASSESS FISH POPULATIONS AND FOULING COMMUNITY DEVELOPMENT ON OFFSHORE OIL AND GAS PLATFORM STRUCTURES.

Susan A. Cox
Carl R. Beaver
Quentin R. Dokken
Center for Coastal Studies
Texas A&M University-Corpus Christi
Corpus Christi, TX 78412 USA

Jay R. Rooker
University of Texas
Marine Science Institute
Port Aransas, TX 78373 USA

In the northwestern Gulf of Mexico the most common material of opportunity for artificial reef development is the steel-jacket structure of oil and gas production platforms. Investigations of fouling community populations as well as finfish assemblages have been conducted primarily by nondestructive techniques. Photographic transects and rugosity measurements are used to determine sessile community development and structure. In addition, 10 cm³ sections of the fouling community are collected for qualitative and quantitative assessment of cryptic species. Rugosity was determined by measuring the relief created by the fouling community organisms between two points set 1 m apart. The degree of fouling is measured as the difference between the circumference measured around the surface of the community and the actual circumference of the bare-pipe structure on which the fouling community is attached. Transect survey techniques and stationary visual census methods are employed for assessing fish populations. Fish counts are conducted simultaneously by two or three dive teams twice each day using stationary count methods. A suite of statistical analyses including ANOVA, Tukey’s HSD, Pearson’s Correlation Coefficient, Shannon Diversity Indices and Morisita’s Diversity Index, is utilized to analyze the data collected.

INTRODUCTION

In the northern Gulf of Mexico there are currently nearly 3,900 oil and gas production platforms on site. The majority of these platforms are concentrated in the northwestern quadrant (Fig. 1). These structures may provide as much as 29% of the hard substrate available for settlement of sessile invertebrates in Gulf waters. Although it is known that platforms create a dynamic artificial reef ecosystem, little understanding of the dynamics or productivity of this artificially created reef ecosystem exist.

For the past 5 years, researchers at Texas A&M University-Corpus Christi have employed diver-based underwater survey techniques in the examination of the biological aspects of oil and gas platforms. Research teams have been trained in the use of various scuba techniques including deep air and mixed gas diving technology. The techniques used are designed to allow maximum safety and efficiency in the data collection effort. Whenever possible, no-decompression schedules are followed. When decompression dives are required, extra surface and in-water support is employed to ensure
maximum safety. An in-water safety decompression system that includes safety lines and surface-supplied breathing gas is employed for all dives.

All diving is conducted within the guidelines of a university-approved manual of scientific diving and under the direction of the university's diving health and safety officer. On-site diving supervision is provided by a university-approved scientific diving supervisor.

The information reported herein is a review of the techniques used by Texas A&M University-Corpus Christi researchers in the data collection of our investigations of the biological dynamics and productivity of platform reefs in the northern Gulf of Mexico.

**MATERIALS AND METHODS**

We surveyed two active offshore production platforms in the northwestern Gulf of Mexico, Mobil’s High Island A389A and British Petroleum’s East Breaks A165. Both structures are in the deep tropical waters near the outer edge of the continental shelf. HI-A389A is approximately 177 km southeast of Galveston, Texas and EB-A165 is approximately 145 km out, in 122 m and 243 m of water, respectively. Both platforms have been on location for more than ten years.

Surface water temperatures range from a winter low 18°C in February to a high of 30°C in late August and early September. The tropical nature of these warm oceanic waters continuously allows for a year-round growing season for many marine organisms. Water clarity is typically good, allowing for maximum light penetration. Currents vary, but are likely influenced primarily by the Loop Current to the east which brings tropical Caribbean water into the Gulf. It is also possible that HI-A389A is primarily affected by the Loop Current and EB-A165 is more strongly affected by nearshore currents traveling up the western shores of the Gulf from southern Mexico. Both structures are affected by short-term but very strong currents resulting from eddy currents spinning off of the loop current.

Through an agreement between the oil companies and Texas A&M University-Corpus Christi, researchers are permitted to live aboard the platforms while conducting field research. This
arrangement provides an increased margin of safety and comfort for the researchers while at the same time saving the research team thousands of dollars in boat charter fees.

EQUIPMENT/PROCEDURES

All dives were conducted using open circuit scuba in various arrangements depending on the technical requirements of the dive. Redundant configurations were used for decompression dives. Nitrox and trimix blends were mixed on-site and used in repetitive dives to increase safety.

All scientific diving was conducted using U.S. Navy no-decompression and decompression tables. All divers calculated their available time at the target depth and two depth ranges below target. All pertinent dive time/decompression information was transcribed to underwater slates and carried with the diver. U.S. Divers Monitor II dive computers displayed depth, and electronic depth/bottom timers served as back-up instruments.

METHODS

Sampling of the fouling community was conducted primarily by nondestructive means. Vertical photographic transects (Bohnswack, 1979) from the surface to 52 m depth were used to describe the fouling community. Transect photographs were taken by a team of two divers equipped with a Nikonos V underwater camera, 28 mm Nikonos lens, and twin Nikonos SB-103 strobes. A stainless steel arm mounted to the base of the camera was used to maintain a constant distance from the substrate. A U.S. Divers electronic depth/bottom timer mounted on the arm appeared in every photograph. Researchers using scuba would descend to the prescribed depth where photographing would commence. Photographs were taken approximately every 1.5 m as the divers ascended along the support structure.

All photographs were developed and organisms identified to the lowest possible taxonomic group and enumerated. Community diversity and dominance figures were derived from this data.

Analysis of Variance (ANOVA) was utilized to determine significant differences in average fouling community diversity along the depth gradient. Tukey's mean separation test was used to determine differences in species diversity between depth zones. Species diversity for each depth zone was assessed using the Shannon-Wiener Diversity Index (Shannon, 1948).

Rugosity measurements (linear measurements of the surface relief created by fouling community organisms) were taken at every 3.05 m depth interval change from the surface to 52 m. Rugosity was determined by measuring the total surface area created by the fouling community organisms along a 1-m vertical transect (Fig. 2). Divers would set markers at 1 m intervals and using a flexible measuring tape, measure the amount of linear surface area created by the fouling community between these markers. Three replicates were taken for each 3.05 m depth increment. Data were recorded on underwater slates and transcribed to computer disk after each dive. No-decompression times at deeper replicates were often extended by use of different mixtures of nitrox. A mixture that provided a PQ of no more than 1.4 at depth was selected. Each dive was planned to keep the team well under the maximum OTU exposure.

Rugosity for each increment is defined as: \[ \Sigma 3(X+1) - 1 \], where \( X \) = linear measurement of surface area.

Degree of fouling was measured as the difference between the circumference measured around the surface of the fouling community and the actual circumference of the bare pipe structure on which the fouling community was attached.

The cryptic portions of the fouling community were defined by examination of a 10 cm\(^3\) section of the fouling community. The sample was collected by divers using scuba. The divers descended to the center of a zone of diversity as defined by analysis of random photographic transects. The depth of the fouling community was measured and determined to be 10 cm. An equal distance in width and breadth was then marked and the sample carefully scraped off the steel substrate and placed in plastic bags.
At the surface the sample was preserved and dissected to determine numbers of cryptic species inhabiting the fouling community.

![Diagram](image)

**Figure 2.** The average of three linear rugosity measurements is multiplied by the circumference of the underlying structure to compute the degree of fouling.

Methods and results of efforts to study the Porifera are reported fully in Adams (1995). The sponge community was photographed in situ by divers using scuba. Two photographs of each specimen were taken; one with a 28 mm lens fitted with a close-up kit at a focal length of 250 mm and one with a 35 mm lens and a 1:2 macro extension tube with a focal length of approximately 90 mm. A 5 cm² sample of each specimen was then collected. In the laboratory spicules were mounted on slides, and each specimen identified to the lowest possible taxon.

Using a line-point intercept method, vertical transects were employed along each of the four corner legs of HI-A389 to investigate abundance and zonation. The transect line was marked at 0.5 m intervals, and for analysis 3 depth zones were identified: upper (0-12 m), mid (12.5-25 m) and lower (25-37 m) depths. Legs were compared for numbers of species of sponges and for total numbers of sponges using a heterogeneity chi-square (Zar, 1984). The null hypothesis for the chi-square is that all four legs are from a homogenous population using the following equation: \[ X^2 = \sum \frac{(f-E)^2}{F} \]

where the observed frequency of a species is \( f \) and the expected frequency is represented by \( F \). Species diversity for each depth zone was determined using the Shannon-Wiener Diversity Index.

The means of numbers of sponges for the dominant species for all three zones were analyzed using an ANOVA to test the null hypothesis. Species were considered dominant if the count was equal to or greater than 20 of 100 observations. For multiple comparisons, Tukey’s HSD was used as an ad-hoc test for each ANOVA.

Methods and results of transect surveys of fish species are reported fully in Rooker et al. (1996). Divers conducted visual surveys during the day and night to determine spatial and temporal patterns in habitat utilization by resident finfish, swimming measured transects along diagonal sections of the platform structure to a depth of 24 m. Statistical analysis included ANOVA, Tukey’s HSD test, Chi-square analysis, Shannon-Wiener diversity indices (\( H' \)) and Evenness (\( J' \)). These data have been collected from HI-A389 only.
Visual surveys of fish populations modified from Bohnsack and Bannerot (1986) were employed to determine community composition and diversity. Survey teams comprised of two or three divers were randomly spaced within the perimeter boundaries of the structure. Divers oriented themselves vertically in the water with adequate separation to ensure non-overlapping fields of survey. Divers would rotate within this position counting individuals of a single species. One rotation was completed for each species counted. Surveys were conducted at depths from 53 m to the surface.

LITERATURE CITED


