

DESIGNING AN ARTIFICIAL REEF AT TITLOW BEACH MARINE PRESERVE

ANNA COMFORT AND MATTHEW HOLROYD

ABSTRACT

The Titlow Beach Marine Preserve is an underwater habitat located at the site of a decomposing ferry dock and various pilings. Due to creosote contamination, the current structures are slated for removal in the near future. The site is often explored by SCUBA divers and is routinely used for marine education purposes. To encourage continued fish and plant life recruitment, the structures will be replaced by an artificial reef. Through a newly formed partnership with the Washington State SCUBA Alliance, Bellarmine Preparatory School Marine Chemistry students designed and configured a rich underwater habitat using interactive GIS mapping and AutoCAD drawings. Environmental data collected by former Bellarmine students were considered in the design and planning process and incorporated into the GIS design map. A diverse mixture of tested and untested structures was integrated into the reef plan to create a prolific habitat that will be accessible to recreational and educational divers.

INTRODUCTION

This paper will discuss the design and implementation of artificial reefs structures in Puget Sound's Titlow Beach Marine Preserve. The project was initiated by the Washington State Scuba Alliance in union with Bellarmine Preparatory School's Marine Chemistry Program and endorsed by Metro Parks Tacoma. Funding was provided by multiple state sanctioned organizations. The goal of the project was to introduce marine life recruitment structures and enhance the dive site by replacing preexisting toxic pilings. This paper will focus on the

methods used in the design and placement stage of the project highlighting the use of ArcGIS 9.2.

BACKGROUND

Titlow Beach has always been a dive location. It is safe, easily accessible, and its pilings provide for a rich marine life. It became a Marine Protected Area in 1992. Since then, Titlow has been a place of learning and recreation for students and divers alike. Currently the Department of Natural Resources is planning the removal of the pilings (denoted purple Figure 5) due to toxic levels of creosote. Base studies in the Titlow Marine Preserve detected multiple carcinogenic substances in sediment and plant and animal tissues. Although the pilings are toxic, they serve as the only habitat for Titlow's marine life. Removal of this habitat will virtually destroy Titlow's ecosystem. In attempt to replace these pilings with a safe and beneficial habitat, Bellarmine Preparatory's Marine Chemistry Program has teamed with Washington Scuba Alliance to design an artificial reef with the help of ArcGIS.

Determining distances underwater poses more difficulties than determining distances over land when using traditional means. However, with the implementation of the ArcGIS spatial referencing system it was much easier to develop the outline of our dive site (Figure 5). We used GIS to determine the final GPS points of our individual dive structures.

DESIGN

There are three specific structures incorporated into the Titlow Artificial Reef Project. The first structure, quarry rock with leaning pillars (Figure 1), is a proven, beneficial habitat that has been evaluated over the last 20 years as successful for animal and plant recruitment in the

Puget Sound waters. Reef balls, our second structure (Figure 2), are hollow half spheres with holes cut in the sides that fish can swim through. The reef balls are designed to be arranged in a stacked pyramidal pattern adding both rugosity and vertical relief to the dive site. The third and final structure used in the creation of our dive site is an artificial ship wreck (Figure 3). The artificial ship wreck is an engineered concrete frame held together with a galvanized steel super structure in attempt to recreate the sensation of diving on a ship wreck.

All three structures are being placed in a statistically analyzable pattern based on three depth contours within the confines of the marine sanctuary. The complete dive site takes up an area of 350 feet by 300 feet. There are three columns separated by two pathways to be used for entrance/exit to and from the dive site (See Figure 4).

Figure 1

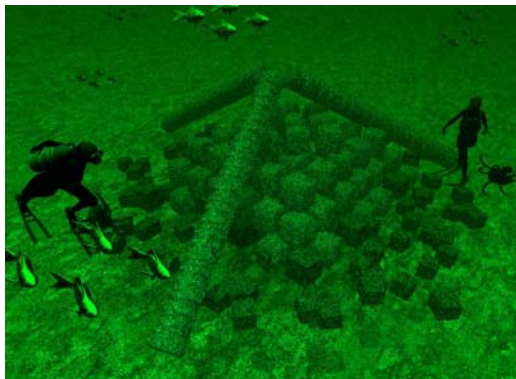


Figure 2

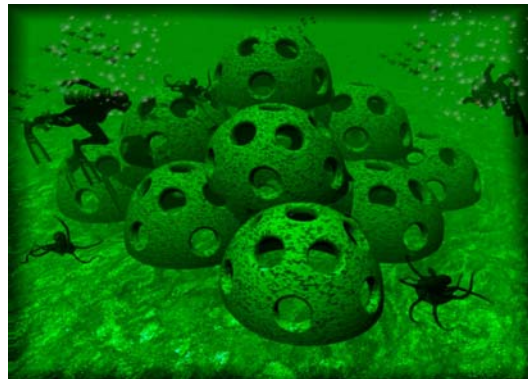


Figure 3

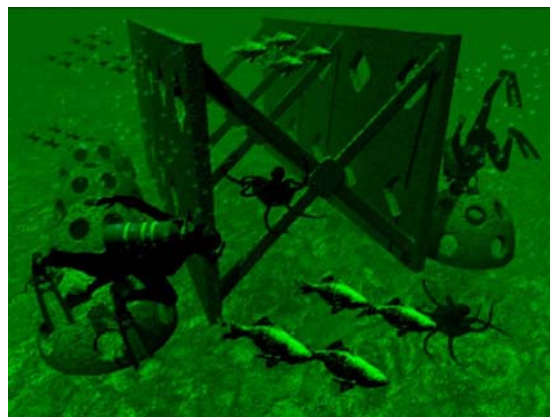


Figure 4

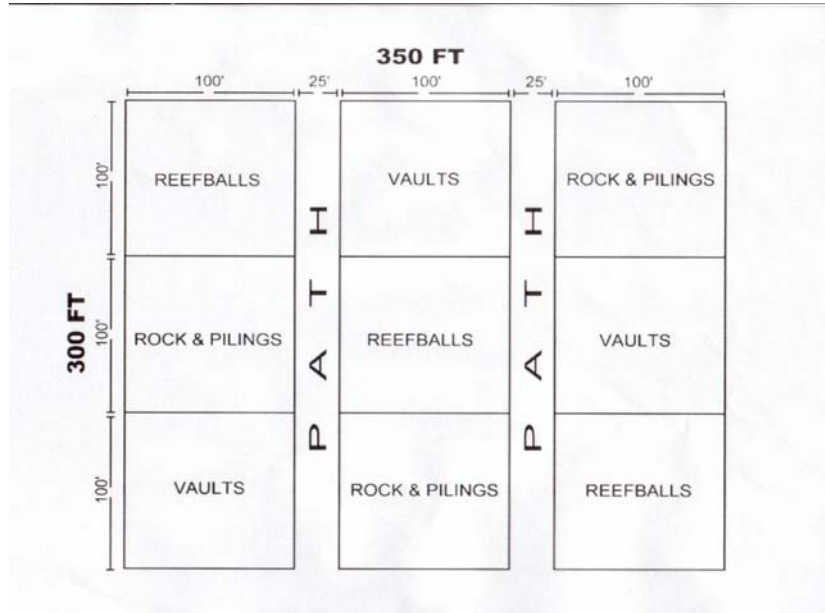


Figure 5



The artificial reef (denoted in Figure 5) is designed to house the existing marine life and promote growth in current populations of marine life. Baseline studies of Titlow's marine life

show that the creosote has bio-accumulated up the food chain allowing only a percentage of the marine life Titlow could potentially sustain to actually survive there. A layer was created using Arc GIS to specify the localized ranges of marine life currently present at Titlow Beach Marine Preserve, and another to depict the projected ranges of marine life after successful implementation of the dive structures. Once the source of pollution is removed and the creosote is naturally diluted it is hypothesized that the artificial reef structures will serve as major recruitment tools in reaching Titlow's maximum life potential. It is hoped that certain species such as the wolf eel, the octopus, and the ling cod will return to the Titlow Beach Marine Sanctuary and take residence in the dive site.

IMPORTANCE

Trusted individuals at the Washington State Department of Natural Resources, members of the Tacoma Dive Community, the Washington Scuba Alliance, and many other scientists involved with underwater recruitment and dive site design have reviewed this design and deemed it beyond satisfactory in its potential for marine life recruitment and dive suitability. The duality of the site is what makes it so unique. Not only does the site create a haven for local wildlife but it creates the opportunity for onsite education. The centralized Puget Sound location of Titlow Beach makes it a perfect spot for study by high school, college, and professional level organizations. The design of the reef was deliberate in order to allow for maximum recreational and educational traffic. Transect studies, wildlife and water quality analysis, recruitment proficiency, habitat analysis, and specie observation are just a few options of marine research that can be conducted upon completion of the underwater park. The Titlow Beach Marine Preserve GIS Map will be a continual work in progress for the Bellarmine Marine Chemistry

Program, and all new information will be catalogued and layered with each additional study taken at the park.

Even though the educational value is priceless at Titlow, safety played a huge role its selection as the site for artificial reef implementation. It is protected in a naturally occurring semi-harbor out of the current track of the main Sound. The boundaries of the Titlow Marine Sanctuary do not exceed a depth contour of over sixty feet in fact most areas do not exceed forty feet in depth. Any diver with basic open water certification will be able to dive the artificial reef. An layer of the Titlow Map denotes the planned activities of the divers through different structures and areas of the dive site. The three levels of artificial structures allow divers of all certification to enjoy the same recruitment structures of Titlow at different depth contours.

CONCLUSION

The artificial reef design and placement will serve as a beneficial habitat for existing marine life as well as recruit other marine life. The artificial reef and protected dive site will serve as an unequivocal educational tool specifically unique to the Puget Sound and Tacoma, Washington. ArcGIS was instrumental in the placement phase of the project and made the implementation of this project possible.