HYDROGRAPHIC & GEOPHYSICAL SURVEYS ON A REEF SITE
Planning a Kelp Mitigation Artificial Reef Offshore of San Clemente, California

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Introduction

Why a kelp artificial reef, and why at San Clemente?

- Compensate for kelp habitat impacts from the San Onofre Nuclear Generating Station
- In-kind, and in-place (nearby) mitigation
- Locate in an area physically suitable for kelp
- Locate in an area that minimizes impacts to existing valuable habitat and substrate
Kelp Habitat – in the San Onofre area
Locations of San Clemente Kelp Mitigation Artificial Reef, San Onofre Nuclear Generating Station, and Pendleton Artificial Reef.
Kelp Reef - Siting Guidelines

As governed by physical conditions and regulatory agency constraint:

- Suitable kelp growth depths: ~ 11 to 16 m.
- A thin (< 0.5 m) layer of sediment on top of bedrock or existing natural hard substrate.
- Near-persistent natural kelp forests.
- Not directly on existing natural hard-bottom substrate.
- At a distance from areas with major sediment deposition.
- At a distance from areas near wastewater discharge or other human perturbations.
- At a distance from areas of historical or cultural resources.
- As near as practical to the SONGS-impacted natural kelp reef.
Mitigation Kelp Reef - Project Schedule

**Phase 1** - General Siting and Design Studies:
- Phase 1 - Construction, **22.4 acres**: Sept. 1999.

**Phase 2** - Sonar and Ground-Truth Studies:
- Phase 2 - Construction, **127.6 acres**: 2007 - 2008.
Phase 1 Reef:

Constructed in Sept. 1999

864-Acre Lease Area

356 Acres Suitable Substrate

56 Modules - Each 40 m x 40 m

22.4 Acres Total
Phase 1 Construction – Derrick Barge and Supply Barge
September 1999, 22.4 Acres of Reef Area Created
Phase 1 – Construction Method - Derrick and Supply Barges
Aerial View, 2002, Phase 1 Reef Modules with Kelp Canopies
Kelp Habitat – Phase 1 Reef Modules
Phase 2: 127.6-acre Build-out Mitigation Reef
Siting Methods and Project Objectives

2005-2006:
- Multibeam sonar surveys – bathymetry and bottom type (sand or hard-substrate)
- Sub-bottom sonar surveys – sand thickness
- Diver ground-truth surveys – verify bottom type and sand thickness, assess biological communities
- Reef siting and design planning

2007- and beyond:
- Kelp Mitigation Reef Construction
- 40-year biological and physical performance study
- Adaptive management process
Survey Vessel: 2005 Multibeam Sonar Surveys at the San Clemente Kelp Mitigation Reef
Methods – Field Equipment for the 2005 Hydrographic and Geophysical Survey at the San Clemente Kelp Reef

The *M/V Locator*, a 25 foot long Parker boat, was used as survey vessel for the project. The vessel was equipped with the following primary equipment for execution of the survey:

- Reson SeaBat 8101 Multibeam Echosounder (MBES), over-the-side mounted
- POS/MV 320 positioning, heading, and motion reference sensor
- CSI DGPS-MAX USCG Differential correction radio-beacon
- GeoAcoustics Model 5110 Sub-bottom Profiler (SBP), over-the-side mounted
- Applied Microsystems Limited (AML) SmartProbe, for Sound Velocity Profiles (SVP)
- FPI’s WinFrog navigation software
- Triton Elics International (TEI) Isis Sonar, DelphMap, BathyPro, & DelphSeismic Software Suite
- CARIS HIPS
Phase 2 Multibeam Survey, October 2005.
Study area: 7.5 sq km, 52 tracks, 295 km total line length.
Phase 2 Multibeam Coverage: Bathymetry, Oct. 2005
Left: Image and Inset Location in the San Clemente Reef Study Area.

Right: Sun-Illuminated Multibeam Bathymetry Image of Kelp Modules.
Comparison of kelp canopy areas - 2002 kelp aerial map (right); with substrate features from the 2005 multibeam sonar bathymetry map.
Sub-Bottom Lines (2) with Historic Core Samples (sand depths in m): Overlaid on Bathymetry
Layout of the Phase 2 Mitigation Reef Proposed Build-out Areas on the 2005 Multibeam Bathymetry Sonar Data.
Phase 2 Reef Study

2005 Multibeam sonar results:

Build-out reef (127.6 acres) and contingency areas (22.4 acres) overlaid on seafloor characterization map.

Substrate from 2005 Fugro Multibeam Survey.
Coordinates UTM Zone 11 (m), NAD83
Phase 2 Mitigation Reef – Proposed Site (127.6 acres)

Overlaid on historical kelp canopy in the lease area - 1967 to 2004.

Kelp canopy areas have been geo-referenced to the substrate features of in the 2005 multibeam sonar data.

Year-Sum is the cumulative number of years that kelp has occurred at a location.
Conclusions

The five-year 1999-2004 study of the 22.4-acre Experimental Reef demonstrated that:

- Sustained kelp growth on a low-profile artificial reef is viable
- Well-placed reef substrate will not disappear into the sediment
- Minimum bottom density of reef substrate meets performance-mandated kelp coverage

2005-2006 Hydrographic & Geophysical Study provides:

- Time-series data (1997-2006) demonstrating that the natural seafloor elevations, seafloor types, and biological communities have not change significantly in the San Clemente area
- Assurance that artificial reef materials in the planned polygons will avoid the potential of burial into the sand seafloor
- Assurance that viable existing hard-substrate biological communities will not be adversely impacted by new reef material placement
- An accurate map for siting the 127.6-acre build-out Kelp Mitigation Reef
The End