RIGS-TO-REEFS SITING AND DESIGN STUDY FOR OFFSHORE CALIFORNIA: ADDRESSING THE ISSUES RAISED DURING THE MMS/CSLC SEPTEMBER WORKSHOP

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INTRODUCTION

At the opening of the Minerals Management Service/ State Lands Commission (MMS/CSLC) conference on upcoming decommissioning challenges, Bill Griffin–one of the "godfathers" of platform decommissioning–stated that the decommissioning of platforms is not a project, but rather a process. A process is more complex than a project and is usually multidisciplinary in nature. What really differentiates a process from a project is the fact that the owner and the engineer/contractor do not make all of the decisions leading to the completion of the work. In the case of a process, regulatory agencies and the public have standing, and thus can demand a role in the decision making process

The next decade will see the decommissioning of a number of large structures in California and elsewhere in the world. The California platforms will be the largest structures ever to be decommissioned–once again, as in the installation of the Hondo Platform in 1978, California will be setting an example offshore. For this and many other reasons, it is time to start preparing for these projects now. The platforms are there, and they certainly will not last forever, the question now is, what to do with them when their service lives are over.

This report presents a rigs-to-reefs plan for Southern California that addresses this upcoming challenge well before it is "too late." This report details:

1. The reasons for implementing a rigs-to-reefs plan,
2. The criteria for reef siting and design, and
3. The location of a chosen artificial reef site.

Certainly, many groups will be impacted by the decommissioning of these deepwater structures, and each of them has concerns and needs that need to be met. The process to meet this goal was begun in 1994 with the first MMS/ CSLC conference to share information about the upcoming removal of the 4-H platforms (Hope, Heidi, Hazel, and Hilda). The purpose of this workshop was not to form a consensus on what needed to be done, but rather to conduct "information transfer." In 1997, the same organizations held another conference, in order to go over the decommissioning of the four platforms, and to look to the future, at the upcoming projects in deeper water (greater than 300 ft, as a general rule). This conference was also an outlet for information transfer, both between the agencies and the public, and between the stakeholders and the platform owners. However, the main thrust of the conference was to start toward building a consensus on what needs to be done with these structures.

This report addressed the next step, suggesting a plan for converting the ten California deepwater platforms from oil and gas producing facilities that act as habitat, to highly productive artificial reefs, whose sole purpose will be replacing and enhancing valuable marine habitat. This conversion process will be done in the least invasive way to the environment, and in a fashion that is economically feasible.

Description of California's Deepwater Structures

Ten deepwater platforms have been installed on the California Outer Continental Shelf (OCS). Structures in over 300 ft of water are generally considered to be in "Deepwater." The platforms range from north of Point Arguello (Irene), to south of Long Beach harbor (Eureka). The exact locations and topography for the structures will be given in a later section. The platforms are currently operated by five entities. Table 1 summarizes the platforms' characteristics and locations.

Need for an Artificial Reef Decommissioning Plan

Platforms have been in place in the Santa Barbara Channel since the late 1950s and early 1960s. People have become accustomed to seeing these platforms. Generally the population of the region prefer not to see these platforms. Not only have the platforms become part of the landscape and part of the infrastructure of California, they have also become part of California's ocean habitat. This is a point that many feel is contentious, but recently, the research community has formed a consensus that artificial reefs (and offshore platforms, serving as artificial reefs) are productive habitat, not just fish attractors (sometimes called FADs).

In 1996 four platforms were removed, using a practice that is currently called total removal – meaning that the platform was severed below the seabed, and completely brought to shore. Along with these platforms, workers also removed literally tons marine life. They also removed a structure, which served as a haven for transient marine life, including

Table 1. Deepwater structures located on the Pacific Outer Continental Shelf.

Lease	Name	Longitude W	Latitude N	Date Installed	Water Depth (ft.)	Operator	No.of Slots	Land Distance (mi)
182	Heritage	120 16 45	34 21 1	10/7/89	1075	Exxon	60	8.2
188	Hondo	120 7 13	34 23 26	6/23/76	842	Exxon	28	5.1
190	Harmony	120 10 3	34 22 36	6/21/89	1198	Exxon	60	6.4
205	Gail	119 24	34 07 30	4/5/87	739	Chevron	36	9.9
217	Grace	1189 28	34 10 46	7/30/79	318	Chevron	48	10.5
315	Harvest	120 40 51	34 28 09	6/12/85	675	Chevron	50	6.7
316	Hermosa	120 38 47	34 27 19	10/5/85	603	Chevron	48	6.8
450	Hidalgo	120 42 08	34 29 42	7/2/86	430	Chevron	56	5.9
301	Eureka	118 6 59	33 33 49	7/8/84	700	CalResources	60	9
441	Irene	120 43 46	34 36 37	8/7/85	242	Torch	72	4.7

but not limited to: fish, pinnipeds, turtles, and crustaceans. These organisms were forced to move to new locations.

The author believes that the removals were unnecessary, and in fact detrimental to California's marine ecosystem. Deepwater offshore platforms provide acres of hard substrate, which can be colonized by all types of organisms. These monumental structures not only just provide a small niche ecosystem, they provide a *huge expanse* of marine habitat. Removals of large structures in the Gulf of Mexico have demonstrated this fact. In one case, when a large jacket was picked up by a derrick barge and towed to a remote reef site, the finfish actually picked up and followed the facility at a comfortable two knots, until they reached the reef site, where the jacket was placed. Their home was moved, but not taken away (Wilson 1996). The following photographs of the Hondo jacket under construction (courtesy of Ben C. Gerwick, Jr.) show the immense size of the deepwater jackets. Figure 1 shows the Hondo jacket under construction in Oakland. Figure 2 shows the immense size of the jacket, against the backdrop of the San Francisco skyline. The casual observer may have no idea exactly how much habitat one of these jackets–even with the top hundred feet removed–represents.

Underwater Habitat Photos

Figures 3 through 7, photographed by a diver exploring the subsea portions of the 4-H platforms, were taken during the late 1980s. Figure 3 shows a sea star and strawberry anemones under Platform Hope. Figure 4 shows barred surfperch under Platform Heidi, while Figure 5 shows miscellaneous rockfish and scallops under Platform Heidi. Figure 6 shows an aggregating anemone under Platform Heidi, and Figure 7 is a shot of brittle stars and Mediterranean mussels on Platform Hope. These photos are a good sample of some of the marine life living on or under the platforms. The pictures were taken in depths ranging from just below the water surface to the jackets mudline framing. The photos help to give some idea of the great biodiversity that can be found under an offshore platform.

Some groups argue that this ecosystem is artificial, that it does not belong where it is. The same people argue that platforms draw marine life away from natural reefs,

Figure 1. Hondo jacket under construction in Oakland, California (Photo - Ben C. Gerwick).

Figure 2. Lower half of the Hondo jacket on the transportation barge (Photo - Ben C. Gerwick).

Figure 3. Sea star and strawberry anemones under Platform Hope (Photo - R. P. Zingula).

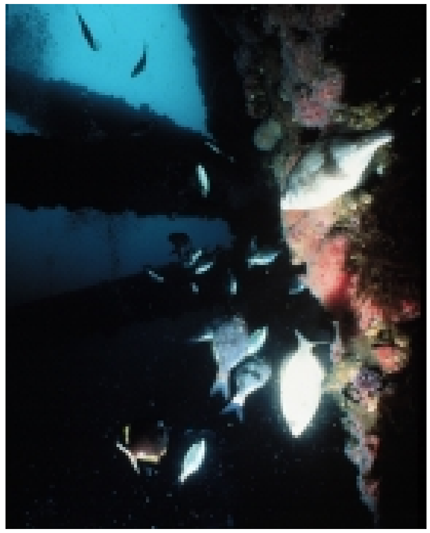

Figure 4. Surfperch under Platform Heidi (Photo - R. P. Zingula).

where they "belong." This is an anthropomorphic argument, and one that scientists have been battling for hundreds of years. It is not up to sociologists and philosophers to determine what is best for marine ecosystems. This choice should be left to the organisms. The organisms flock to colonize offshore platforms, in fact the level of biodiversity on these platforms is far greater than it is on natural reefs (Zingula, pers. comm. 1996).

Holistic Decommissioning Strategy

It is important to look upon the platforms as a whole set. These are after all California's deepwater structures, not just a few groups of platforms, owned by five different companies. They make up a unit greater than the sum of its parts. If they are viewed as a disconnected group, rather than as an interrelated ecosystem, then when the time comes to remove one of them, the notion comes to mind to take the path of least resistance. The impulse is to avoid any trouble with permitting, and to just completely remove it. This series of tactical decisions will result in the total removal of all of the structures, and hence all of the habitat.

In 1996, during the preparation for the decommissioning of the 4-H platforms, the United Anglers of Southern California proposed that the platforms be used as artificial reefs for study in the Big Sycamore Canyon artificial reef site. At that point in the project process, the owner was unwilling to pursue that option, because it was not feasible to go through the arduous permitting process again. The resulting project achieved the goal of decommissioning the platforms according to the existing guidelines and regulations, but it did not truly meet the needs of all the stakeholders.

That is why, for future projects of this type, there needs to be a plan in place ahead of time, to serve as a vehicle for creating artificial reefs. Texas and Louisiana each have one of these plans. They prescribe what materials are suitable for artificial reefs, and where they can be placed. The Reefs

Figure 5. Miscellaneous rockfish under Platform Heidi (Photo - R. P. Zingula).

Figure 6. Aggregating anemone on Platform Heidi (Photo - R. P. Zingula).

Figure 7. Brittle stars and Mediterranean mussels on Platform Hope (Photo - R. P. Zingula).

Programs utilize roughly one tenth of the platforms that are decommissioned in the Gulf of Mexico, and the number is growing each year (National Research Council, Marine Board 1996).

California has an artificial reef program, which has been in existence since 1985, with reef sites permitted and being used up and down the southern California coast, but to date, no offshore platform parts have been used as artificial reefs. Details of the program will be given in a later section.

To summarize the rationale behind a rigs-to-reefs program:

1. California's offshore platforms provide productive habitat for marine life.

2. These habitats have become an interconnected ecosystem, interacting with the previously existing communities around them.

3. If the structures are not considered as part of a whole, conventional wisdom dictates their removal as the "path of least resistance."

4. Given the nature of oil and gas production, it will not be necessary to decommission all of the deepwater structures at one time.

5. Due to 4 above, a plan needs to be in place, so that when it becomes time to decommission a platform, it is feasible to maintain it as an artificial reef, rather than remove it.

6. There must be guidelines to follow, and an accepted plan, detailing the best way to preserve the part of the structure that is a valuable marine habitat.

7. Entities that follow the plan should be shielded from perpetual lingering liability.

DESCRIPTION OF THE CALIFORNIA ARTIFICIAL REEF PROGRAM

The California Department of Fish and Game (DFG) has developed and implemented an Artificial Reef Plan for Sport Fishing Enhancement (Wilson et al. 1990). The document details:

1. The different types of reefs created by the DFG, as well as private entities,
2. Acceptable materials for artificial reefs,
3. The exact locations and configurations for the reefs, and
4. Some information on the productivity of the reefs.

This document also identifies a number of proposed future reef sites within the Santa Barbara Channel and the Santa Maria Basin. To date, none of these reef sites have been permitted or utilized (D. Bedford, pers. comm. 1997).

The primary goals of the reefs created by the DFG Reef Plan are the production of fish stocks, the creation of sportfishing opportunities, and the furthering of research into the function of artificial reefs in California (Wilson et al. 1990). Most of the reefs created by the DFG are made out of quarry rock, however, some were made using donated materials, such as broken up concrete, old ships, and even a toppled missile launch test tower. Quarry rock is the material of choice at this time, for many reasons. It certainly fits the DFG's materials criteria (Bedford 1991), and it is readily available from a quarry on Catalina Island, that makes it easy to transport and place. These quarry rock reefs are highly complex, and of low relief. Low relief reefs are sometimes created to try to enhance the growth of giant kelp, in order to spur the formation of that type of ecosystem. Information provided by the DFG from the 1990 paper "Artificial Reef Plan for Sport Fishing Enhancement" (Wilson et al. 1990) is available upon request for those interested in the existing artificial reefs program.

Environmental Site Conditions

Climate

The Santa Barbara Channel climate is generally mild, with offshore temperatures ranging from 50 to 65°F (10 to 18°C) year-round; 90 to 95% of the mean annual precipitation occurs between November and April; offshore areas receive about 7.5 to 11.5 inches of rainfall annually (State Lands Commission 1994).

Water Quality

Mean surface temperatures in the Santa Barbara Channel average 58°F; salinity about 33.5 ppt. with very low variability. Dissolved oxygen generally ranges from six to seven mg/l at the surface and is about 2 mg/l at a depth of 825 ft. Santa Barbara, Montecito, Summerland, and Carpinteria all discharge secondary-treated sewage to the Channel at about 12.23 million gallons per day. These effluents contain about 20 mg/l suspended solids and 60 mg/l chemical oxygen (State Lands Commission 1994).

Tidal

The Santa Barbara channel tide is classified as semidiurnal; entering through the eastern end, sweeping up the coast, and exiting the western end. Tidal currents are about 10 cm/sec in the open channel, which provides good flushing. (State Lands Commission 1994)

Seas

Inside the Santa Barbara Channel, seas are low (3 to 6 ft) most of the year. The Channel Islands shield much of the area from large swell. Certain wave headings dominate due to the geometry of the islands and the channel. Outside the channel, north of Point Conception, seas run much higher, and persist for much of the year. This offshore area is not shielded from wind and waves by the Channel Islands. (Culwell, pers. comm.)

California Artificial Reef Program – Design Criteria for Artificial Reefs – Siting and Design

The DFG has published criteria for artificial reef siting and design (Wilson et al. 1990). Other stakeholder groups have also voiced a few siting and design criteria. These are compiled below and should be considered in any design.

Attraction vs. Production

Reefs should be designed in a manner so that they do not just attract marine life, but actually produce it. A productive reef increases the total biomass, whereas a reef that is designed incorrectly can draw marine life from surrounding natural reefs. One way to ensure that artificial reefs are productive is to site them in an area that is not close to any natural reefs, or that does not provide an adequate substrate, such as a sandy bottom area.

Water Depth

Artificial reefs should be accessible to all stakeholders. For this reason, placing them in deep water is discouraged. Most people think of an artificial reef in deep water merely as a way of disposing of a platform jacket, and not as an artificial reef. On the other hand, it would be a new experiment to create a deepwater artificial reef – one that could provide valuable data. In the Gulf of Mexico, most artificial reefs are in the shallowest water possible. Of course, the International Marine Organization (IMO) guidelines should be observed and taken into account as part of the design criteria. Reefs in shallow water receive more sunlight thus adding more energy to the system. This facilitates the growth of macro algae and other photosynthetic organisms that would not be present on a deepwater reef. Reefs in shallower water are also accessible to sport divers.

Clearance

Artificial reefs should have the least amount clearance between the reef top and water surface. Of course, the "least amount of clearance," is not simple to determine. The DFG recommends that the reef be submerged by twice as much distance as it is tall. This rule applies to low relief reefs (Wilson et al. 1990). The IMO guidelines dictate 55 m of clearance, however, most people believe 85 ft of clearance is adequate. (Pulsipher 1996) The minimum amount of clearance should be supplied for safe navigation, but no more than is necessary.

Complexity

Artificial reefs should support high complexity. Quarry rock reefs have been used in the past because the interstices between the rocks provide places for juvenile fish and other organisms to shelter. Shell mounds underneath the 4-H and other platforms provide this kind of complex habitat, as do natural reefs.

Platform jackets on the other hand are complex, but on a much larger scale. Figure 8 shows the complexity of the Hondo jacket structure.They will need to be augmented in some way, to provide the kind of complexity that a quarry rock reef provides. The combination of low relief-highly complex quarry rock and the high relief jacket structure will make for an excellent reef.

Figure 8. Photo of part of the Hondo jacket, showing the high complexity (Photo - Ben C. Gerwick).

Substrate Type

Any kind of reef substrate should not be smooth and flat. Quarry rock and platform members that are encrusted with marine growth fit this criterion. On the other hand, ships, which provide large expanses of steel plate, are now deemed unacceptable. Large platform members may not provide this substrate type. A small portion of the jacket structure will be composed of large leg members, however, most of the top portion of the jacket is composed of smaller framing such as braces and horizontals. These members have small diameters on the order of two to three feet, an acceptable scale.

Some environmentalists are concerned that leaving part of the jacket in place will have an adverse effect on the environment. A platform jacket is composed of welded steel members. Steel certainly has an impact on the environment, however this impact could be good or bad. In some cases the addition of iron to the ocean environment has a beneficial effect. According to Jim Ivey (Ivey 1998):

> "Iron has been shown to be a limiting trace element for diatoms in certain environments. The area that has been especially studied is the equatorial Pacific. They actually did an experiment where they dumped huge amounts of iron into the water and measured the algae growth. Look in oceanographic literature for the Ironex cruise. Also for more information look for papers by a researcher by the name of John Martin. He originally promoted the hypothesis of iron limitation."

Iron is a limiting trace element and the addition of iron to sea water can accelerate the growth of macro algae. Since the 1982-1983 El Niño, forests of giant kelp have been decimated, and reefs made from high relief steel jackets could have a positive impact. This has certainly not been studied in the Santa Barbara Channel, but it would be an interesting study.

Proximity to Harbors

For the same reason that reefs should be located in shallow water, they should be located in close proximity to ports and harbors. This way they will be accessible to the stakeholders, such as fishermen, naturalists, and sport divers.

Augmentation Types

As stated previously, the jacket structures will need to be augmented with some material. The current material of choice is quarry rock delivered from Catalina Island. This is the material of choice because it is easy to deliver, because the quarry rock can be placed on a barge at the quarry site. The barge can be towed to the reef site and placed from the barge using a front-end loader. Another material that fits the criteria (Bedford 1991) is crushed concrete, however, this material must be available at the time of the project.

Reef Preserve/Non-Reef Preserve

One decision that needs to be made before the creation or utilization of any reef site, is whether it will be opened or closed to fishing. The Big Sycamore Canyon Reef site is separated into two portions. One portion is closed to sportfishing, while the other is not. This provides researchers an opportunity to study the effects of sportfishing on marine life. An artificial Reef created from platform jackets should be open to sportfishing. Currently, most platforms are off-limits to fishermen, however, they recognize that platforms are very good places to fish and would like to use them. Merit Mcrea stated that platforms Helen and Herman provided some of the best calico bass fishing that he had ever seen. (Mcrea pers. comm. 1997.)

How a Rigs-to-Reefs Solution will Meet the Artificial Reef Design Criteria

Reefs constructed out of platform jackets will be high relief, but of a lower complexity than the quarry rock reefs. The jackets are complex, but on a very much larger scale, as shown above.

According to the DFG, parts of the structure are not complex enough to be used purely as an artificial reef, and should be augmented in some way. A design to increase the reef's smaller-scale complexity could include the addition of quarry rock, or perhaps the installation of a roof structure, as suggested by one participant at the MMS/CSLC conference.

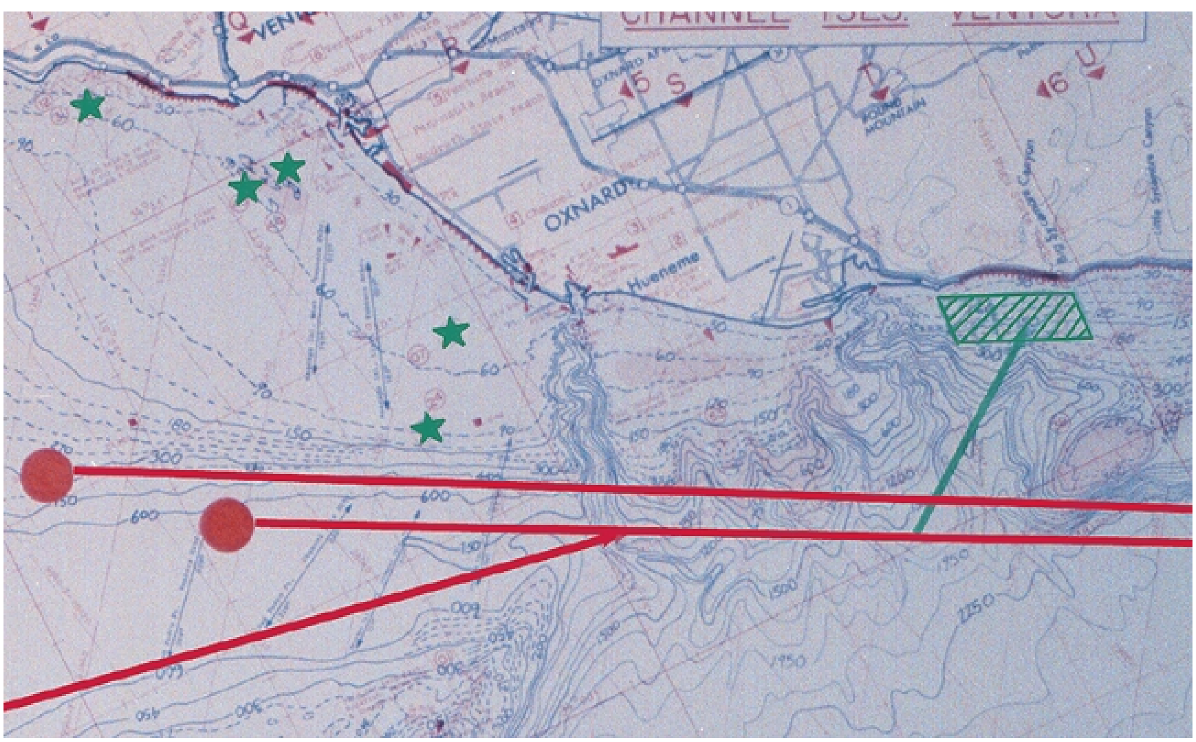

Figure 9. Jacket top reef site location.

Reef Site Location and Description

A reef site has been chosen for placement of jacket pieces, however, it is not the only suitable site. The selected site lies just outside the boundaries of the Big Sycamore Canyon artificial reef site. The Sycamore Canyon site ranges in water depth from 30 to 120 ft (D. Bedford, pers. comm. 1997). This water depth will not provide adequate clearance for 110 ft tall jacket section, and its attached reef augmentation structure, so the structures will have to be placed outside of the official site boundaries. These boundaries can be changed of course. The existing permit for the Big Sycamore Canyon artificial reef site also expressly prohibits the use of oil rig materials (D. Bedford. pers. comm. 1997). At the time the reef site was created it was believed that any mention of oil platform parts would jeopardize the permit process. The Sycamore Canyon reef site lies between Point Mugu and Big Sycamore Canyon. A map of the area surrounding the reef site is included as Figure 9.

The reef site is close to Port Hueneme and Channel Islands Harbor. The site boundaries are shown in green. Other permitted artificial reef sites in the area are indicated with green stars.

SUMMARY AND CONCLUSIONS

This report presents a rigs-to-reefs siting and design plan for southern California that addresses this upcoming challenge of decommissioning deepwater platforms. This report details:

1. The reasons for implementing a rigs-to-reefs plan,
2. The criteria for reef siting and design,
3. The existing California Artificial Reef program, and
4. The location of a chosen artificial reef site.

Input from industry and agency representatives was used to evaluate and modify the design and siting criteria at every stage of the process. The author believes that a rigs-to-reefs plan is feasible, good for California, and cost effective. To use a cliché, it is a win-win situation.

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