Rigs to Reefs: Exploring the Future of California's Offshore Oil and Gas Platforms

Emily Callahan & Amber Jackson
Center for Marine Biodiversity and Conservation
Scripps Institution of Oceanography

Abstract

Rigs-to-Reefs (R2R) is a process, managed and maintained by a governmental agency, in which oil companies choose to modify a rig so that it can continue to support marine life. Although the decommissioning process is easily and routinely done in shallow waters, the depth and mass of most of California's platforms make their eventual removal complex and costly. As oil wells are deemed to be no longer economically efficient and offshore production slows to a halt, California stands at an important policy crossroads. To address this issue, California policy makers must decide whether a R2R program serves ecological and economic goals better than the current status quo of complete rig removal. Many advocates claim that the R2R program atones for diminished diversity caused by human impacts near shore by providing an artificial habitat in which fishes, crustaceans, and marine mammals can thrive. Additionally, social and economic benefits make the R2R program an attractive alternative to complete rig removal. In contrast, opponents of the R2R program argue that capped oil sources near artificial reefs pose severe threats of liability, pollution, and other risks. Through a cost-benefit analysis, comparing and contrasting these two opposing points of view, this paper evaluates the economic and ecological efficiency of the Rigs-to-Reef program in California. Our principal finding is that a well-designed and efficiently implemented R2R program for California would likely result in direct and indirect benefits that far exceed the costs. Based on our evaluation, we recommend that a state and/or federal program be established that would benefit both the offshore environment and the citizens of California.

I. Introduction

There comes a time when the useful life of an oil or gas platform comes to an end—at least when it comes to drilling for hydrocarbons. When a rig reaches this point, Federal law requires oil and gas companies to remove their offshore platforms within one year of terminating an outer-continental shelf land lease.[1] This process entails decommissioning the rig by sealing the wells, completely removing the drilling rig and all associated infrastructure and restoring the seabed to its original condition. Although this process is easily and routinely done in shallow waters, the depth and mass of most of California's platforms make their eventual removal complex and costly. With over twenty oil and gas platforms primed for the potential to be decommissioned within the next decade, California stands at an important policy crossroads. To address this urgent issue, California policy makers must decide whether or not the Rigs-to-Reefs (R2R)[2] program serves ecological and economic goals better than the current status quo of complete rig removal.

In California, there are twenty-seven oil and gas platforms standing in both State and Federal waters, that provide a unique microcosm of life in a blue ocean setting. Ranging from above Point Arguello to off Orange County, these platforms with their lattice-work superstructures of pilings, columns, beams, and pipes, offer an artificial rocky substrate for life to spawn, breed, feed and grow to maturity, as *de facto* artificial reefs.

A variety of economically valuable fishes, invertebrates and marine mammals associate with offshore oil and gas platforms. The presence of this marine life invites the question as to whether or not platforms are producing life and therefore can be considered Essential Fish Habitat (EFH), or merely attracting life from other habitats. EFH is defined as an aquatic habitat where fish spawn, breed, feed or grow to maturity. This is an important question because through the Rigs to Reefs program, California's Department of Fish and Wildlife assesses offshore platforms as EFH and can permit waivers that keep the platforms in place if they are deemed necessary for the conservation of marine life. Determining whether platforms are actually producing rather than merely attracting marine life is an important step in the environmental review phase of decommissioning an offshore oil and gas platform through the R2R program.

The Infrastructure of Offshore Oil and Gas Platforms

Offshore oil and gas operations utilize a variety of infrastructure types that include product transfer stations, support structures, piers, pipelines, and platforms. The platform itself employs a drilling rig to extract oil from subsurface wells. The infrastructure of the offshore platform is comprised of the topsides (i.e., above-water structures), the jacket (i.e., legs and associated structural elements), and the well conductors (i.e., located at the base of the platform legs, beneath the seafloor).

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[1] 30 C.F.R., (Q), §250.1700 *et seq*. (2002). Removal guidelines specify that platforms must be cut down to fifteen feet below the ocean mud line.

[2] Assem. Bill 2503, 2010 1st Ex. Sess., ch. 5.5, 2011 Cal. Stat.

Decommissioning Options

When evaluating the potential costs and benefits of the R2R program, it is important to understand the alternative decommissioning options currently available. Oil and gas companies that operate offshore facilities in California have a number of viable options for the decommissioning of infrastructure. Decommissioning options range from complete removal to a myriad of leave in place options, such as reefing or other alternate uses. Each alternative is described below.

Complete Removal

Complete removal involves cutting the platform legs at its base on the sea floor and removing all platform structures above. Prior to any initial removal activities all wells are plugged and abandoned[3] below the sea floor. These wellheads must be protected from any potential future damage such as trawling, anchor drags/strikes, dredging, or any other activity that could damage them. This is typically achieved by placing an armored surface cap directly over the wells[4].

Partial Removal

The partial removal option is unlike complete platform removal, in that it leaves part of the subsurface structure in place. In partial removal, the topside structures are removed, brought to shore and recycled or refurbished and re-used. The jacket and well conductors are severed and removed to a depth of at least 26 m (approximately 85 feet)[5]. These are then removed and brought to shore, and recycled in a manner similar to what occurs in the complete removal option. The cut off depth of 26 m was established in order to provide sufficient collision protection to even large vessel traffic and is recognized by the United States Coast Guard as protective[6]. Under this scenario the jacket and sea floor structures are left in place to serve as an artificial reef structure.

Partial Removal with Reefing

The leave in place 'reefing' variant on the partial removal scenario, involves the placing of the section of the jacket and well conductors that was cut off onto the sea floor as additional artificial reef structural elements. This is accomplished by placing the entirety of the section on the sea floor intact, or, by placing sub-sections of it on the sea bottom. Placement may be near the remaining jacket section or it may be removed to a designated

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[3] A well is abandoned when it reaches the end of its useful life or is a dry hole. The casing and other equipment is removed and salvaged, cement plugs are placed in the borehole to prevent the migration of fluids between the different formations and the surface is reclaimed. "Oil and Gas Well Drilling and Servicing eTool: Plug and Abandon Well". OSHA

[4] Proserv Offshore, 2010

[5] Ocean Science Trust, 2010

[6] Stephan et al., 1990

artificial reef zone. California does not currently have designated artificial reef zones, although these zones do exist for States that border the Gulf of Mexico[7].

Complete Removal with Deep Water Reefing

Deep-water disposal of the jacket and well conductors that are removed from a decommissioning site, is a modified option of the complete removal scenario. Instead of removing the structure to an on-shore disposal facility, the jacket and well conductor sections are floated out to a designated deep-water disposal site and placed on the sea floor to function as a deep-water artificial reef. In the United States, this option presents some additional regulatory challenges. Deep water reefing may be subject to additional regulatory oversight as an evaluation of the need for ocean disposal would need to be presented before the United States Environmental Protection Agency (USEPA) for compliance under the US Ocean Dumping Act[8].

Artificial Habitat

Artificial habitat facilitates artificial biodiversity[9]. Artificial habitats are prevalent in coastal areas threatened by a range of anthropogenic stresses, including overfishing, pollution, mining, coastal development, and climate change. They offer an opportunity to enhance local marine biodiversity and fisheries, without addressing the actual anthropogenic pressure or the trajectory required to naturally achieve enhancement of biodiversity.

In California, the R2R program is an active example of a compensatory, artificial habitat with the potential to mitigate anthropogenic losses and degradation of natural habitats. By decommissioning and leaving the platform in place offshore, R2R offers a habitat where fish can spawn, breed, feed or grow to maturity. However, critics such as the Environmental Defense Council (EDC), stress that R2R is inconsistent with the artificial reef guidelines currently in place for California. These guidelines state that when creating an artificial habitat that will support California fisheries, the site must be selected based on ecosystem need. Leaving the platform where it is, under the pretense that it will enhance ecosystem productivity, is not addressing ecosystem need.

Rigs to Reefs Program: Decommissioning Offshore Oil and Gas Platforms

From the first signature on a lease, oil and gas companies know that when the useful life of an oil and gas platform comes to an economic end, it must be decommissioned, dismantled and disposed of. Obsolete platforms in federal waters must be removed in accordance with the "Idle Iron" policy of the Bureau of Safety and Environmental Enforcement (BSEE) which requires inactive facilities be removed in order to prevent

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[7] Kaiser and Pulsipher, 2005

[8] 33 U.S.C.§1401 *et seq.* (1972) Title I of the Marine Protection, Research, and Sanctuaries Act [MPRSA]

[9] Walker & Schlacher 2014

serious safety, environmental, and navigational risks[10]. The complete removal of offshore platforms is a destructive process that may employ the use of explosives, and is not only costly and dangerous, but also destructive to the surrounding marine ecosystem. The R2R program offers an alternative; it is a unique, regulated disposal option, that under certain circumstances allows biologically valuable structures to remain in the marine environment as artificial reefs.[11]

R2R is a process, managed and maintained by a governmental agency, in which oil and gas companies choose to modify a rig so that it can continue to support marine life. The decommissioned platforms, like other artificial reefs, attract various encrusting organisms such as barnacles and bivalves which colonize them and, in turn, attract fishes and other marine life as found on natural reefs. There are three methods for converting a non-producing oil and gas platform into an artificial reef: (1) partially remove the platform; (2) topple the platform in place; and (3) tow-and-place the platform into a reefing area. Partial removal typically relies on non-explosive means to cut the platform at levels of no less than 85 feet below the mean waterline. The ultimate depth of the artificial reef is determined by a Coast Guard assessment and by the willingness of the liability holder to pay for any required navigational aids. Compared to toppling in place, partial removals result in higher reef profiles and less trauma and loss of platform uses by associated reef organisms. Toppling in place, as the name implies, uses non-explosive or explosive severance to cut piles and lay the jacket[12] on its side. The tow-and-place platform method entails removing the platform from the seafloor and towing it to a designated reefing area.

In California, critics[13] of the R2R program are concerned by the lack of protocol necessary to assess and implement which decommissioning method would best benefit California ecosystems in accordance with the artificial guidelines currently in place. A comprehensive assessment of habitat and ecosystem need is imperative when choosing a decommissioning method, as seen in the Gulf of Mexico.

II. **Gulf of Mexico: a Model for the Future Decommissioning of Offshore Oil and Gas Platforms in California**

R2R is well established in the Gulf of Mexico, with over twenty years of experience converting decommissioned oil and gas platforms into artificial reefs. Both Texas and Louisiana have adopted legislation that establishes state trusts to oversee R2R.[14] To date, over 188 platforms have been converted to artificial reefs in the Gulf. Although an

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[10] 30 C.F.R. §250.1711

[11] Waiving is subject to certain restrictions, such as approval by the Army Corp of Engineers and acceptance of liability by a responsible state agency.

[12] The 'jacket' refers to the steel frame supporting the deck and topsides on a fixed offshore platform.

[13] EDC, California Trawlers Association, Santa Barbara-based environmental and commercial fishing organizations

[14] The Louisiana Fishing Enhancement Act of 1986 (LA. REV. Stat. 56:639.1 *et seq*.; Act 100) has created a process by which ownership and liability pass from the oil and gas companies to the state for obsolete platforms that meet the Act's criteria. The Texas Artificial Reef Act of 1989 (Tex. Parks & Wildlife Code 89.001 *et seq.*) is similar.

initially impressive figure, it only represents approximately 8 percent of all decommissioned platforms[15]. The percent converted is low because most obsolete platforms in the Gulf are in shallow water, where the cost of complete removal with subsequent salvage and scrap sales is less than the cost of artificial reef conversion.

However, in deeper, federal waters, R2R significantly reduces what an oil company pays when decommissioning an oil platform and absolves the oil company of responsibility for future damages and liability.[16] [17] Seeking to capitalize on potential savings, oil companies with platforms in deeper water have eagerly participated in R2R programs. According to Chevron representative Ayana McIntosh-Lee, it can cost up to $5 million for oil companies to remove platforms from federal waters. In comparison, it costs only $800,000 to convert the platform into an artificial reef.[18]

The R2R programs established by Texas and Louisiana do not receive state or federal funding. [19] These artificial reef programs are funded by oil and gas company contributions and the subsequent interest that is earned on those payments. Oil companies participating in decommissioning platforms for R2R donate one half of the cost savings to artificial reef programs. In turn, the governmental agency assumes liability for the artificial reef and the fund handles any ensuing maintenance costs. Currently, the Louisiana R2R fund has a balance of $18 million and earns approximately $1 million in interest annually; the Texas fund has at least $4 million.[20]

In this study we assume that a R2R program in California would function similarly to the model implemented in the Gulf of Mexico. Specifically, we assume that oil companies would apply for R2R status when a platform becomes economically obsolete. The platform and rig would then be inspected on a case-by-case basis and eligibility would be granted by the appropriate governmental agency and would be subject to review under the National Environmental Policy Act. We also assume that for each rig accepted into the R2R program, the associated oil companies will remove the topsides of the platform to some depth below the ocean surface, as directed by the Coast Guard. The oil company would then donate fifty percent of the cost savings to a trust fund for reef maintenance and liability costs.[21]

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[15] Winmar Consulting Services, Inc., "Removal Cost Estimate, Pacific OCS Platforms," (May 2003) [Hereinafter Removal Cost Estimate].

[16] Dauterive, Les. "Rigs-to-Reefs Policy, Progress and Perspective." OCS Report MMS 2000-073, US Department of the Interior, Minerals Management Service, New Orleans, October 2000.p.2.

[17] There is liability in perpetuity for the wells. If the wells ever leak then the oil company (if it still exists) or some entity of it, would hold liability to fix it and the associated damages.

[18] "Fish Farms Questioned," The Daily Advertiser, April 5, 2005.

[19] Love, M. S., Caselle, J. E., and Snook, L. Fish assemblages around seven oil platforms in the Santa Barbara Channel area. *Fishery Bulletin* 98 (2000)[Hereinafter Platforms in the Santa Barbara Channel]

[20] *Id.* The Louisiana balance was obtained from an interview with Rick Kasprazak, Artificial Reef Coordinator for Louisiana's Department of Wildlife and Fisheries, Aug. 11, 2003.

[21] California Department of Fish and Game has been proposed to be held responsible for managing R2R.

III. **California**

The strata below the seabed off the coast of California is rich in hydrocarbons. This valuable underwater resource developed millions of years ago through the process of organic deposition, accumulation, decomposition and transformation. Over millions of years, as organic material accumulated, the resulting heat and pressure broke down the organic layer into a dark and waxy substance known as kerogen. Over time, fueled by the extreme heat in the Earth's crust, kerogen transforms into lighter hydrocarbon molecules to form the building blocks of crude oil and natural gas.

To extract these oil and gas resources, oil companies must first obtain a lease to the seabed from either the state or the federal government. Off the coast of California, there are 27 active production platforms, both in state waters (3 nautical miles offshore) and in federal waters (between 3 and 200 nautical miles offshore).[22] Neither the state nor the federal government has issued any new leases since 1969.

The US Bureau of Ocean Energy Management, Regulation and Enforcement (BOEM) oversees the leasing and decommissioning of offshore oil platforms in California. BOEM estimates that within 5 to 20 years, the oil and gas platforms on existing leases off the coast of California will stop producing oil and gas in quantities sufficient to be considered economically viable. At this point the state and federal leases will require oil companies to decommission the rigs, by sealing the oil wells, completely removing the production platform and all associated infrastructure and restoring the seabed to its original baseline condition. The depth and mass of most of California's platforms make their eventual removal complex and costly.

The removal costs are high for California because a quarter of California's platforms are in water over 400 feet deep, a depth at which no fixed platform has ever been decommissioned before in California. Therefore oil companies must pay for the development of new technologies in addition to the cost of removal and disposal or recycling of the scrap metal. Protecting marine resources from contamination is another important cost that oil companies cover by mitigating for, or removing the mussel and other invertebrate shell matter that accumulate on the ocean floor around platform pilings. These shell mounds often contain drilling byproducts such as hydrocarbons and metals and they are currently being addressed to ensure that marine resources are not exposed to contamination. It is estimated that the total cost of removing all existing California platforms is over 1 billion dollars; more evidence that decommissioning offshore oil platforms in California is extremely costly.[23]

In 2010 Governor Arnold Schwarzenegger approved legislation A.B. 2503 that grants oil companies the right to conditional partial removal of offshore oil platforms through the R2R program. Many Californians consider the transformation of decommissioned oil rigs to artificial reefs to be mutually beneficial, saving the oil companies money in extraction

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[22] *See* Outer Continental Shelf Lands Act 43 U.S.C. §§1301 *et seq* (1953)

[23] Removal Cost Estimate, *supra* note 8.

effort while providing a valuable habitat for fish species to aggregate and produce on. However the application of this program has been controversial in many settings.

IV. Potential Costs and Benefits of R2R in California

California policy makers must assess the potential costs to determine whether the R2R program serves ecological and economic goals better than the current status quo of complete rig removal. In this section we examine and quantify, using available data, the potential costs and benefits of R2R in California.

Gaining Perspective on the Opposition to the R2R Program

There are numerous complications associated with maintaining an oil and gas platform as an artificial reef site through the R2R program. The complexity of this issue merits research and understanding into all viewpoints in order to come up with the most effective solution. An interview with Linda Krop, Chief Counsel for the Environmental Defense Center (EDC), whose current view point is that the R2R program is an ecologically, economically, and politically ineffective program for the state of California, offered critical perspective on opposition to the R2R program.

According to Ms. Krop one of the primary concerns of the EDC regarding the R2R initiative is that the political and legal infrastructure currently in place in California lacks the precedent to properly manage an offshore oil and gas platform as an artificial reef. One of the issues that the EDC sees with the R2R program in California is that the programs in the Gulf of Mexico and California are very different and too often the program in California is touted as having exactly the same in function and legislation. In the Gulf of Mexico the oil companies select and designate sites where the ecosystem would benefit from an artificial reef in order to address a specific issue, such as the development of a recreational fishery.

By contrast, in California she notes that "they just want to leave them (the platforms) where they are. Which doesn't make any sense, because the state is not selecting appropriate locations based on need."[24] Krop explained that California does indeed have very good artificial reef guidelines, however, "they are completely inconsistent with the platform decommissioning proposal" when it comes to creating habitat, the types of fisheries involved, and how the site would be designed. "The whole point of the artificial reef program for the state through the Department of Fish and Wildlife, is to enhance productivity" and with the current state of the R2R decommissioning process in California, "that's not the point, the point is to have these oil companies save a lot of money."

*"*Even though there are some platforms that do have life around them, that's because they're in operation so they have a constant feed stock of new, live shells. Once these

[24] The US Congress passed the Sustainable Fisheries Act of 1996 requiring regional fishery management councils to designate spawning, breeding, feeding, or growth to maturity areas required to support a sustainable fishery as ''essential fish habitat'' (EFH). Sustainable Fisheries Act 16 U.S.C. §1801, (a)(6), (1996).

platforms are decommissioned and toppled, they're not going to have the same attraction for sea life as they have now." In addition, past experiences have demonstrated that once these platforms are decommissioned, "piles of debris are left behind, they call them shell mounds, and these shell mounds are contaminated." For example, in 1996 Chevron was required by the state to remove four of their platforms; in the aftermath of their removal Chevron left behind huge mounds of debris and claimed that "they were creating habitat, and that they were not toxic at all." A sentiment that both Linda Krop and the EDC disagree with.

The EDC declared these areas to be dead zones and subsequently insisted that the state study these 'mounds'. Core samples revealed that all four sites harbor very toxic chemicals and the EDC's main concern is that at some point, these chemicals could get displaced by either human factors, or natural factors such as earthquakes.

In regards to the total removal of the platforms, the question remains, what do you do with the leftover scrap metal? One option is that the scrap metal be sold and shipped off to China or another country more willing to accept this metal and process the waste (consisting of many tons of dead invertebrates). However, there has been expressed concern regarding the carbon foot print associated with the shipment of the waste as well as the moral aspect of dumping our waste into someone else's backyard. However, in regards to alternative options for removal, the EDC remains unsure of the answer to this problem. Linda Krop went on to state that currently total platform removal represents only some of the short-term impacts, air quality and loss of habitat. The long term effects of total platform removal are just as unknown as the long term effects of keeping the platform in place.

When the four oil platforms were removed by Chevron in the 1990s, the remaining debris mounds were marked with buoys to prevent fisherman from entangling their gear and to alert shipping traffic to their location. However, Krop explained, this method was not successful and these buoys would routinely disappear, by either sinking or being accidentally severed. In fact, some fishing boats did tangle their gear, and subsequently filed damage claims. In response, Chevron agreed to equip the fishermen with GPS units on their boats to enable them to evade the debris mounds. However, the EDC remains concerned about the "long-term safety and legal liability issues associated with marking these (buoys) as navigational hazards."

Maintaining an oil and gas platform as an artificial reef site is bound to be controversial, especially when faced with the realities of offshore energy development. The Rigs to Reefs program remains a viable force to be contended with in light of the complexities associated with responsible decision making regarding the ocean and its resources.

Potential Costs

The major potential costs of R2R in California are diverse and affect many entities. For example, certain commercial fishermen’s groups oppose the program, due primarily to concerns over equipment damage. In testimony before the California State Lands

Commission in December of 1999, a representative of one of California's trawlers associations noted that trawlers do not want reefs of any kind, and instead prefer a "clean ocean bottom" to reduce the risk of snagged nets and damaged gear.[25] It is our understanding, however, that in the Gulf of Mexico only one incident of trawling equipment damage has been reported in over 15 years of artificial reef operation.[26] With proper navigational aids installed around the reef, trawlers should be able to avoid this externality[27] by maintaining a safe distance from the reef. Shrimp trawlers in the Gulf evidently drag their nets within a quarter mile of reefed platforms and report that these areas tend to be more productive than others.[28] Moreover, although removing the platforms completely would increase the fishable area for trawlers, the scientific evidence detailed below suggests that trawlers could incur costs from platform removal in that fish stocks would be depleted, both from the immediate damage caused by explosives used to sever the platform base, if explosives are used, as well as long-term effects from loss of habitat and spawning grounds.[29] As a result, we consider trawling gear damage to be an externality that is unlikely to generate economically significant losses.

Another cost is the one-time cost to establish operational guidelines for evaluating and accepting rigs into the program and for maintaining them once converted to reefs, this cost is estimated to be around $250,000.[30] As for ongoing maintenance and operations for R2R, Louisiana spends approximately $250,000 annually to monitor and maintain the 111 converted platforms remaining off its coast.[31]

Liability is another major potential cost because any structure in the ocean, whether man-made or natural, poses a potential hazard for ocean vessels. In R2R, an oil company gives up rights to the lease through a "quit claim" lease. This indicates that the oil company is no longer liable for issues dealing with a platform's structure. However, there is liability in perpetuity for the wells. If the wells ever leak then the oil company (if it still exists) or some entity of it would hold liability to fix it and compensate for any associated damages. Ownership and liability for the structure subsequently passes from the oil companies to a governmental agency, with the oil company providing an indemnification. Critics worry that up-front indemnification may prove to be inadequate.[32] Insurance broker and risk management advisor Marsh & McLennan estimates that annual insurance premiums, per

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[25] *See* the testimony of Mike McCorkle, Senior Representative of the Southern California Trawlers Association, before the California State Lands Commission, Dec. 3, 1999.

[26] The shrimper filing the claim failed to heed the warning placed on buoy markers around the artificial reef, and as a result, his claim was thrown out. Authors' interview with Rick Kasprzak, Artificial Reef Coordinator for Louisiana's Department of Wildlife and Fisheries, on Aug. 12, 2003.

[27] An externality results when the actions of one individual (or firm) have a direct, unintentional, and uncompensated effect on the well-being of other individuals or the profits of other firms. *See* "Markets and the Environment"

[28] Platforms in the Santa Barbara Channel, *supra* note 12, at 21.

[29] As neither of these effects is easy to quantify, the net impact on trawlers is unclear.

[30] *See* Alpert's bill text <http://info.sen.ca.gov/pub/01-01/nill/sen/sb 0001-0050/sb_1_bill_20010914_enrolled.pdf>.

[31] Interview with Rick Kasprzak, Artificial Reef Coordinator for Louisiana's Department of Wildlife and Fisheries, Aug. 11, 2003.

[32] *See, e.g.,* the testimony of Warner Chabot, Director of the Pacific Region of the Center for Marine Conservation, before the California State Lands Commission, Dec. 3, 1999.

rig, would run around $25,000, although they anticipate that the premiums would decline as more rigs are added to R2R.[33]

Another concern and cost is pollution. A few opponents worry that the structures would corrode and thus cause pollution or prove unstable. Generally, offshore platforms are made of steel, which over time corrodes (rusts) into iron oxide. However, if the steel is covered with crustaceans, it is sealed off from oxygen and will corrode more slowly.[34] Moreover, the rate of corrosion in the ocean is low and most experts believe that oil platforms would last upwards of two to three hundred years without maintenance before collapsing. [35] In the Gulf, where R2R has been implemented for over 20 years, corrosion has not been a problem. The Louisiana Department of Wildlife and Fisheries notes that, "The use of obsolete oil and gas platforms in Louisiana has proven to be highly successful. Their large numbers, design, longevity and stability have provided a number of advantages."[36]

Potential Benefits

Surveys of offshore oil and gas platforms in California reveal that they do harbor rich assemblages of marine organisms, including many fishes and invertebrates that most often occur on natural rocky reef substrates. The particular species present on any given platform depends primarily on the biogeographic setting of the platform and its depth, in addition to several other factors. Although these platforms provide a substrate for marine life to spawn, breed, feed and grow to maturity, the platform's contribution to regional stocks is the crucial metric for evaluating its ecological impact.

In a detailed six-year study, experts in this field concluded that, "platforms act as de facto marine refuges."[37] In fact, oil platforms appear to be "functionally more important as nurseries" than actual natural rock outcrops.[38] Juvenile rockfish, several species of which are currently recognized as over-fished in the state of California, were found in higher densities at several of the platforms as compared to nearby natural reefs.[39] In Texas, R2R program science made similar conclusions: "By providing food and shelter, artificial reefs can enhance overfished populations of resident reef fish… rigs make ideal artificial reefs because they are environmentally safe, are constructed of highly durable and stable materials that withstand displacement or breakup, and already support a thriving

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[33] Correspondence between Mary R. Berry of Marsh & McLennan and George Steinbach, Executive Director of the California Artificial Reef Enhancement program, July 23, 2003. Berry notes that Marsh does not have off-the-shelf policies or pricing guidelines for insurance of this type, so the estimate is a rough one.

[34] *See* the Aug. 23, 1998 talk by James Wiseman, a deepwater engineer with Winmar consulting.

[35] Platforms in the Santa Barbara Channel, *supra* note 12. *See* the discussion of reefed platform life span.

[36] *See* Louisiana Department of Wildlife and Fisheries website <www.wlf.state.la.us>.

[37] Platforms in the Santa Barbara Channel, *supra* note 12.

[38] *Id.*

[39] Platforms in the Santa Barbara Channel, *supra* note 12. The authors suggest three reasons for the finding: first, platforms physically occupy more the the water-column than most natural outcrops; second, because there are fewer large fish in the midwater habitat where the platforms are located, predation is likely lower; and third, the offshore location and extreme height of the platforms "provide great delivery rates of planktonic food for young fishes.".

ecosystem."[40] Thus, while research questions remain,[41] scientific evidence suggests that the R2R program would in fact be an ecologically beneficial program in California.[42]

A substantial body of research indicates that artificial reefs produce biomass and export energy to the surrounding ecosystem and supports the ecological importance of R2R. Additionally, these rigs attract a remarkable quantity and variety of marine life and improve existing fish populations, benefiting commercial fishing interests. Artificial reefs act as major hubs of fish and fishing, and are a critical component of several multi-billion-dollar growth industries in the Gulf Coast, whose estimated worth is close to $7.3 billion. Commercial fishing in California has been on the decline since 1970. In that year, California's share of the U.S. harvest, based on the dollar value of commercial landings, was 14 percent; by 1990 the state's share had dropped to 4 percent; and by 2001 it had further declined to 3 percent.[43] In order to begin to restore this declining population, federal fishery authorities instituted an offshore rockfish closure along the continental shelf off California's coast.

Approximately half of the rockfish species valuable to commercial fisherman have been recorded at southern California platforms. Members of the rockfish genus (*Sebastidae sabastes*) dominate the list, with 32 out of 52 federally managed rockfish documented at platforms[44]. Research on these populations suggest that the existence of oil platform structures could contribute to an increase in California's rockfish populations. As Love *et. al*. notes, "In some locations, platforms may provide much or all of the adult fishes of some heavily-fished species and thus contribute disproportionately to those species larval production." Further, "Platforms usually harbored higher densities of young-of-the-year rockfishes than natural outcrops and thus may be functionally more important as nurseries." We argue that the ecological benefits of the R2R program have the potential to make significant economic contributions to the commercial fishing industry.

The recreational tourism industry is also likely to reap the benefits of converting oil platforms to the R2R program. The California Trade and Commerce Agency Division of Tourism estimate that the travel industry and associated recreation in California generates approximately $55.2 billion annually (6.5% of the gross state product) and supports almost 700,000 jobs statewide.[45] Recreational scuba divers favor R2R because the converted platforms offer a dense array of marine life and provide unique underwater photography opportunities. Sport fishermen, another source of tourism dollars, also tend

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[40] *See* Texas Parks and Wildlife Department website <www.tpwd.state.tx.us>.

[41] Platforms in the Santa Barbara Channel, *supra* note 12. Love and his colleagues list several, in fact.

[42] Note that full rig removal would require the use of explosives, killing any surrounding fish and potentially damaging the auditory systems of nearby marine mammals. Complete removal would kill the invertebrate life attached to the platform legs as well. *See* Love et al., *supra* note 2, at ix.

[43] Annual Commercial Landing Statistics, National Oceanic and Atmospheric Administration <http://www.st.nmfs.gov/st1/commercial/landings/annual_landings.html>.

[44] See Helvey 2002

[45] *See* Tourism and Recreation <http://resources.ca.gov/ocean/97Agenda/Chap5Tourism.html>.

to support artificial reef programs.[46] Bear in mind that if the rigs were designated as "no take" zones, fishermen would initially incur the cost of avoiding these areas in the short term. However, in the long term as overfished species' populations' rebound and fishing restrictions are lifted, fishermen would benefit from improved fisheries. This point is further cemented by the bioeconomic fisheries model.[47]

Finally, the largest economic benefit would come from the cost savings contributed by oil companies to the designated responsible governmental agency. Winmar, a consulting company that managed the decommissioning of over 250 platforms in the Gulf of Mexico, prepared estimates of the decommissioning costs for California's oil and gas platforms located in federal waters.[48] Table 1 reports their main findings.

Table 1. Estimated One-Time Cost Savings From Partial Rig Removal*

Decommissioning Method	Low Cost	Median Cost	High Cost
Complete Removal	$875M	$1,200M	$1,600M
Rigs-to-Reef In-Place Partial Removal**	$375M	$540M	$600M
Potential Savings	$500M	$660M	$1,000M

Source: Winmar CA POCS Decommissioning Costs Final.
Notes: * Assumes 23 rigs are decommissioned. ** Assumes the remaining rig would extend from the seafloor up to a depth of 85 to 100 feet below the waterline.

Table 1: Winmar predicted cost savings from partial rig removal

The findings in Table 1 reveal that California oil companies would save significant funds with the development of a R2R program. In fact, these estimates far exceed the savings experienced to-date in the Gulf by several orders of magnitude. The driving factor behind this difference in cost savings is that oil and gas platforms off California's coast are in much deeper water on average than those in the Gulf. Although deep-water platforms exist in the Gulf, the vast majority of them (and almost all of those removed to-date) are in shallow water, typically 100 ft. In contrast, almost all of the California platforms are in deep water, reaching depths of over 1,200 ft. As a result, the complete removal process of the California platforms will be more complicated to design and implement than typical Gulf platform removals. These deep-water decommissionings are also liable to be more risky for the workers conducting the removal, and require the development of new technology.[49] The complicated nature of California platform decommissioning implies

[46] Testimony of Tom Raftican, United Anglers of Southern California, before the California State Lands Commission, Dec. 3, 1999.
[47] In the bioeconomic fisheries model, the stock that maximizes the average level of growth also maximizes the sustainable yield. *See* "Markets and the Environment"
[48] Removal Cost Estimate, *supra* note 15.
[49] Authors' interview with George Steinbach, Executive Director of the California Artificial Reef Enhancement program, July 2, 2003.

that the average cost savings from partial removal and conversion to an artificial reef are likely to be high.

Table 2. Estimated One-Time Cost Savings From Partial Rig Removal By Platform Depth

Depth	Number of Platforms	Median Cost Savings Per Platform	Partial Rig Removal Total Cost Savings
100 to 225 Feet	10	$6.4M	$64.0M
225 to 450 Feet	6	$14.0M	$84.0M
450 to 850 Feet	5	$54.0M	$270.0M
850 to 1,200 Feet	2	$120.0M	$240.0M
Total	23		$658.0M

Source: Winmar Summary Report Update R2, 3/7/2000.
Notes: Assumes 6 rigs in less than 100 feet of water generate no savings (the fifth group). Assumes that all rigs would be partially removed, with the remaining rig extending from the seafloor up to a depth of 85 to 100 feet below the waterline. Savings are calculated as compared to full removal.

Table 2: Winmar estimated California cost savings organized by rig type, by splitting the offshore platforms into five groups, based on platform depth. This table presents the cost savings by depth for four of the five groups.

Table 2 highlights the strong positive correlation between a platform's depth and the cost savings generated as a result of R2R. The results from Winmar's study suggest substantial economic benefits from establishing R2R in California. Converting just one rig in shallow water (100–225 ft) would contribute $3.2 million to a R2R fund for reef maintenance, marine research, and conservation projects.[50] Another $3.2 million would accrue to the shareholders of the oil company. The remaining question is whether these benefits outweigh the costs identified earlier.

Brief Summary of Potential Economic Benefits

To demonstrate that a R2R program would be economically beneficial to California, we will summarize the quantifiable costs: $250,000 in one-time expenses to establish R2R, $250,000 annually to cover maintenance, and $25,000 per platform annually for liability insurance. Using a conservative example, we will assume that three of the ten rigs in 100–225ft of water are due for decommissioning and receive artificial reef status. This would result in a $9.6 million payment to a designated California governmental agency. After covering program set-up costs and the first year of funding, $9 million would be left for investment. At an interest rate of 3.58 percent, the interest earnings for the first year would be in excess of $320,000.[51] Thus, with as few as three of the shallowest platforms participating in R2R, California could spend interest earnings only to easily cover the annual operating expenses while still being able to devote over $50,000 a year

[50] The median cost savings of $6.4 million multiplied by the company contribution of 50%

[51] The current rate for 20-year Treasury bills is 4.48 percent. Federal Reserve Statistical Release, Dec 3, 2013. <http://www.federalreserve.gov/releases/h15/current/h15.pdf>

to marine research. Additionally, oil and gas company stockholders will benefit from $9.6 million in potential cost savings.

Oil company participation in R2R will, of course, be sensitive to the designated donation rate. If donation rates are set too high, companies will have little incentive to participate, as they will see little in the way of savings. An economically efficient outcome must be met by maintaining a balance between ensuring that rigs will be available for conversion and ensuring funding for the program, research and conservation projects.

V. **Conclusion**

California has entered a new era of outer continental shelf oil and gas activity. The decommissioning of offshore oil and gas facilities to convert to artificial reefs is rapidly becoming an issue of public concern, scientific study, and policy debate. Understanding the ecological and economic potential for offshore oil and gas platforms to be used as a compensatory habitats for degraded natural systems[52] is a critical first step for appropriate planning and use of these structures as a tool to manage reef ecosystems into the future[53]. Our principal finding is that a well-designed R2R program for California would likely result in direct and indirect benefits that far exceed the costs. There would be benefits for the state, tourists, researchers, the marine environment and equity owners. Based on our evaluation, we recommend that a state and/or federal program be established that would benefit both the offshore environment and the citizens of California.

[52] *See* Burton et al. 2002

[53] *See* Carr and Hixon 1997; Perkol-Finkel and Benayahu 2005; Svane and Petersen 2001

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