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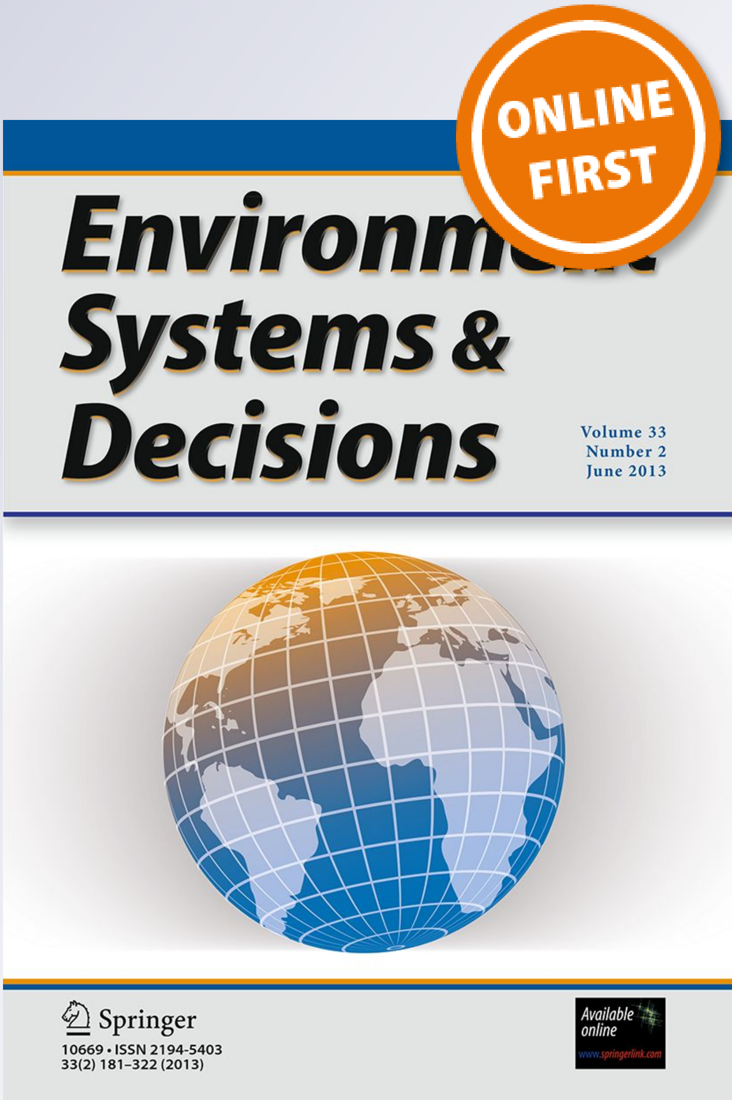

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Use of retired oil and gas platforms for fisheries in the Gulf of Mexico

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Abstract

Petroleum resources are declining on the continental shelf and will, eventually, result in the loss of ~30,000 jobs in related industries. Retired oil and gas platforms could be redeployed to culture fish and employ citizens in coastal areas. The Energy Policy Act 2005 Section 388 of Public Law [PL] 109-58 30 CFR 285.1000 Subpart J encourages the use of the retired structures for alternate uses. At present, there are no fishermen currently taking advantage of this legislation. We suggest amending existing laws to improve the likelihood that retired platforms are used to culture fish and invertebrates. In the future, the abandoned oil and gas infrastructure could also be used to recover stranded petroleum and reserves located in deeper horizons.

Keywords Offshore platforms · Sustainable fisheries · Ornamental fish · Natural products · Reef organisms · Stranded oil and gas

1 Introduction

In the 1990s, there were ~4000 fixed platforms in Federal waters; today, there are ~1800. They were the largest collection of artificial reefs in the world (Stanley and Wilson 2000). Based on an average life span of 17 years, only ~200 have a life expectancy beyond 10 years (Bureau of Safety and Environmental Enforcement [BSEE] 2018). Dismantling offshore platforms and their associated pipelines will strand 40–55% of the existing oil and gas, ~28% of which could be recovered with emerging technologies (Advanced Resource International [ARI] 2005; Godec et al. 2013; DiPietro et al. 2015; Kuuskraa and Malone 2016).

New regulations could provide an avenue to extend the life of these platforms (30 CFR 285.1000 Subpart J), after which the "stranded" oil and gas may well become profitable to produce again. They are home to one of the most prolific ecosystems in the oceans (Wilson et al. 2003; Claisse et al. 2014; Ajemian et al. 2015) and contain coral, algae, bacteria, and sponges that produce anti-viral, anti-bacterial, and anti-cancer compounds (Rouse 2009; Florida Atlantic University 2016). Offshore platforms culture reef organisms similar to a natural reef system; they passively culture reef-dependent fish and invertebrates. They provide habitat and nutrients essential to reef-dependent organisms.

The Japanese government has invested over $8 billion in an ambitious fisheries enhancement program which utilizes structures that are similar to our platform jackets (Grove et al. 1994; Adrianto et al. 2005). They stock, feed, and raise fish in the open ocean. Comparisons show that our oil and gas platforms are ten times larger and three times more durable than Japanese designs (Sheehy and Vik 1982; Quigel and Thorton 1989; Reggio 1989; Blaine 2001).

Section 388 of the Energy Policy Act (EPAct) of 2005 (Public Law [PL] 109-58) promulgated the "Renewable Energy and Alternate Uses of Existing Facilities on the Outer Continental Shelf" program (30 CFR 285.1000 Subpart J). The new Federal legislation allows retired oil and gas platforms to be redeployed for alternate uses such as the production of wind, wave, and current energy, sustainable fisheries, or any "marine related purpose." These revenue- and job-generating options have gone unutilized, while the

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oil and gas industry is spending ~$1.2 billion a year removing these platforms (Decomworld 2010, 2015).

Despite economic incentives and enabling legislation, oil and gas companies are reluctant to leave the structures in the water due to concerns over liability. If the oil and gas platforms are properly maintained, they are designed to survive up to 100 years (in the absence of exposure to catastrophic weather events) (Kaiser et al. 2011a). If they are toppled and left in place, it is estimated that they would maintain a suitable reef habitat on the ocean floor for ~300 years (Reggio 1989).

In this overview, we will discuss the culture of ornamental fish, coral, and other marine invertebrates that possess useful nutritional and pharmaceutical value. We will examine the value of these platforms with respect to

- The culture of ornamental fish and invertebrates;
- Organisms that produce valuable, novel natural products/pharmaceutically valuable compounds;
- Recreational fishing;
- Sustainable fishing techniques, such as sea farms/mariculture;
- Stranded oil and gas that, if the platform infrastructure were preserved, would be available in the future;
- Aquaculture/mariculture, including raising fish in platform-associated, suspended net-pens, will not be discussed in detail here, because it has been already been discussed extensively elsewhere (Kaiser et al. 2003, 2010, 2011b; Kolian and Sammarco 2005; Bernstein 2015). You are respectfully referred to these documents for further information on this topic.

We estimate the potential fishery production, revenue, and jobs based on these studies: Bell et al. (1998); Johns et al. (2001); Hiett and Milon (2002); Kolian and Sammarco (2006); Rouse (2009); Sammarco (2014); Kolian et al. (2017); also, the production, revenue, and of jobs produced through the recovery of stranded petroleum resources, are based on available data: Advanced Resource International (ARI) (2005); Godec et al. (2013); DiPietro et al. (2015); Energy Information Administration (EIA) (2016); Kuuskraa and Malone (2016). Finally, we offer some recommendations for advancing the utilization of retired platforms for fisheries.

2 Ornamental fish

The offshore platforms naturally culture ornamental fish. "Ornamental fish" is a generic term used to describe aquatic organisms sold in the aquarium trade. The U.S. imports $200–$330 million of ornamental fish annually (Wabnitz et al. 2003). On platforms, they are abundant in the upper levels of the water column. This is one reason that it would be better to leave the platforms standing in place—to culture ornamental invertebrates and fish.

The harvest of resident ornamental reef fish such as those desirable in the aquarium trade does not require the use of nets or traps because site-fidelity behavior prevents them from moving into a pelagic environment. Such movement will increase mortality risks due to predation. There is no need to add fish feed into the system. Ornamental fish are opportunistic feeders and graze on drifting plankton or on organisms that colonize the platform substrate. These ornamental reef fish feed, mate, and reproduce on and around the platform substructures, while receiving all of their biological needs from the local platform environment (Kolian and Sammarco 2005).

Small ornamental fish could be harvested in a sustainable manner by SCUBA divers using handheld water suction device. Naturally occurring invertebrates could be harvested by cut and scrape from the pilings and transoms and the specimens would be placed in fish net bags and brought to the surface where they would be deposited in a tank on the vessel.

They could be kept alive in tanks and subsequently transported to shore. There is little doubt that ornamental fish are the highest valued product that can be harvested from a coral reef. Pound for pound, ornamental fish are several times more valuable than food fish (Wabnitz et al. 2003) and costs associated with the harvest are similar to traditional methods of fishing.

We noted that the average number of corals and other ornamental invertebrates on one deep-water platform, ~500,000 coral specimens (Sammarco et al. 2012; Kolian et al. 2017) and preliminary assessments of ~40,000 aquarium fish. Our revenue estimates for wholesale trade of coral were ~$20/invertebrate specimen and ~$10/for a tropical fish (S. Porter personal observation). Assuming a 10% yield of standing stock which is ~50,000 invertebrates and 4000 fish/year, this operation would generate ~$1,400,000/platform/year. There are ~600 remaining deeper water platforms (BSEE 2018) that possess coral (Sammarco et al. 2004, 2012; Kolian et al. 2013, 2017).

3 Novel natural products with pharmaceutical value

Some marine invertebrates that grow on the platforms possess novel compounds that can serve as useful nutritional and pharmaceutical products (Rouse et al. 2009). Sammarco and Coll (1992); Cooper et al. (2014) reported that the most common reef organisms, such as corals, possess bioactive compounds. Murti and Agrawal (2010) listed 46 marine species that are producing bioactive compounds and some of these organisms have been observed on offshore platforms such as coral, octocoral, sponge, algae, and marine bacteria.

Rouse (2009) analyzed invertebrates on five platforms. Preliminary screening of the samples found over 400 species of bacteria that produce bioactive compounds and novel secondary products. In addition, they found 24 bioactive microalgae which composed 50% of the species observed in that study. They found that 20% of these algal species exist only on oil and gas platforms.

The value of these organisms for medicine and human nutrition is not yet known. Only a few reef marine species have been marketed as pharmaceutical products and some are responsible for producing derivatives of compounds sold as pharmaceuticals. Others are undergoing clinical trials (Murti and Agrawal 2010). Additional studies would be required to discover their value as health and nutritional products. There are about ~600 structures in > 30 m depth in the Gulf of Mexico (BSEE 2018).

4 Artificial reefs for recreational purposes

Oil and gas platforms are a favored destination for Louisiana sport fishermen. Approximately 70% of the offshore fishing trips target these structures (Stanley and Wilson 1989). Installing artificial reefs is expensive ($140/m^2) (Kolian and Sammarco 2005). Artificial reefs have, however, proven to be a worthwhile investment. Florida's artificial reef programs are generating $2.8 billion of income annually and produce 34,900 jobs (Bell et al. 1998; Johns et al. 2001). The economic impact derived from recreational use of offshore oil and gas platforms has been estimated to be $324 million per year, while simultaneously producing 5560 full-time jobs in the marine recreational industry (Hiett and Milon 2002). To replicate the equivalent area occupied by artificial reefs currently existing in the form of offshore platforms would cost ~$18 billion (Kolian and Sammarco 2005, 2008). The platforms have great economic value standing as they are.

5 Sea farms and natural stock-enhancement

It has been proposed to build a "sea farm" (offshore fish mariculture) incorporating the salvage materials from shallow-water platforms (< 30 m) into a larger system, offshore of (> 30 m) traditional fish grounds (Reggio 1996; Kolian and Sammarco 2005). A standing deep-water platform, with 20 or 30 retired shallow-water structures placed around it, would create exceptional fish habitat. These structures would provide a suitable settlement and refuge site for drifting reef-dependent larvae, habitat that is scarce in the region (Hernandez et al. 2003; Lindquist et al. 2005).

Japanese fishery researchers involved in the production of sustainable fisheries on artificial reefs in that country reported that one vessel with a crew of 3–5 would be able to sustain a profitable harvest on 1800 m^3 of reef habitat over the period of one year (Kolian and Sammarco 2006). The average volume of a 4-pile jacket in depths 10–30 m is ~12,000 m^3 (Kolian and Sammarco 2005). The Japanese reefs are usually smaller (< 50 m^3) compared to offshore platforms and the structures are distributed over a greater area (Sheehy and Vik 1982). We estimate that a 12,000 m^3 structure would support at least one vessel part-time to harvest the organisms (Kolian and Sammarco 2006). Each vessel could employ two or three fishermen. Currently, there are ~1200 suitable platforms in waters > 10 m depth in the Gulf of Mexico.

6 Stranded oil and gas resources

The decline of offshore oil and gas production will lead to significant volumes of oil and gas being "stranded," (or left behind) in these fields. ~50% of the oil and gas resources in both state and Federal offshore waters (< 183 m depth) are expected to be "stranded" after the removal of offshore platforms. This is because the cost of extraction is expected to exceed potential revenues derived from the fields, using traditional production practices (ARI 2005; EIA 2014).

Recovery rates and efficiencies, however, continuously improve with advances in technology. An analysis of 99 large state and Federal offshore oil fields, including 80% of the crude oil resources, shows that, with new CO_2 enhanced oil recovery (CO_2-EOR) technology, ~4.5 billion barrels of incremental oil (28% of this stranded resource) is technically recoverable (ARI 2005; Godec et al. 2013; DiPietro et al. 2015; Kuuskraa and Malone 2016).

In the case where there were 4.0 billion barrels of potential oil resource in the Gulf of Mexico (out of a potential 15 billion barrels), and this were developed over a 40 year time frame, this would produce the following:

- A production of 200,000–250,000 barrels per day;
- > 8000 jobs to be retained within the Gulf oil and gas industry;
- Increased economic activity totaling $500 million per year within our coastal communities; and
- Increased state and federal revenues of > $250 million per year. Under current tax legislation, > 90% of that would go to the Federal government.

The potential economic benefits from maintaining this offshore infrastructure are substantial. Significant as yet undiscovered gas resource potential may still exist in deep formations on the continental shelf. The Federal government estimates that as much as 55 trillion cubic feet (Tcf) of technically recoverable natural gas exists on the continental shelf (< 183 m depth) of the Gulf of Mexico at formation depths of > 4500 m. Saving the existing platform infrastructure could support long-term production of these deep-gas resources (Kolian and Sammarco 2005).

7 Discussion

Approximately 9% of the retired platforms are toppled over in order to convert them into artificial reefs. It is better to leave a platform standing rather than cut or topple it. This is because most of the organisms that reside in the upper 25 m do not survive if the habitat is relocated to deeper water. This is because there is insufficient light at deeper depths to support their growth and survival (Sammarco et al. 2004, 2012, 2013; Dokken et al. 2000). Also, their food supply changes and the transition to deeper water are not successful. Therefore, ~ 90% of the resident reef fish are lost when a platform is "reefed" (Wilson et al. 2003) and the potential use of the associated platform and pipeline to recover any stranded resource is eliminated when a structure is toppled or removed.

Sometimes commercial and aquaculture fisherman overlap in their target species. In the northwest Gulf of Mexico, the shrimp, crabs, oysters, and menhaden make up 91% of the commercial harvest. Here, we suggest the culture of corals, ornamental fish, and some food-fish on the platforms in waters > 30 m. This area is deeper than where most commercial trawl fishermen, crabbers, and oyster lugers operate (Southwick 1997). At present, fishermen do not harvest ornamental fish or benthic invertebrates on the platforms. Sea farming/mariculture, ornamental fish, and sustainable fishing proposals would involve the employment of commercial fisherman.

We suggest leaving a platform in a standing position to culture ornamental fish and a variety of invertebrates. The stranded offshore oil resources represent a hidden benefit awaiting the future application of more advanced recovery practices. Leaving the platforms in place to culture marine organisms avoids much of decommissioning costs and the potential harm to the environment, human health, and the economy.

Permits to use an offshore platform for sustainable fisheries could be issued under the 30 CFR 285.1000 Subpart J program. As mentioned earlier, this regulation allows applicants to use retired platforms for "marine-related purposes." It permits retired platforms to remain in the water, after oil and gas production has ceased, as long as they are involved in a legal operation.

The cost of a surety bond for eventual platform removal and maintenance costs could be prohibitive and represent an obstacle to the economic success of many types of fishery-related alternate-use applications. Currently, if an alternate use venture fails, and the new user cannot remove the structure, then the Federal government holds the previous owner responsible for removing the structure. This is commonly referred to as the "boomerang clause." In a similar manner, catastrophic liabilities could fall back on the previous owner/operator. It would be necessary to change this legislation, in such a way as to provide the new operator with some protection and also to relieve prior corporate owners of responsibility and liability for a structure that they no longer own or operate.

8 Recommendations

8.1 Address the liability issue

We believe that the new legislation "Renewable Energy and Alternate Uses of Existing Facilities on the OCS, 30 CFR 285.1000, Subpart J" holds great promise for the U.S.; however, it does not address the issue of general liability and long-term liability for decommissioning and management issues. The ideal option is to transfer the responsibility for removal liability to the new owner and those removal cost funds could support the success of the new alternate use operator.

If the alternate user is unable to maintain the structure and must break his lease, one possible option might be to amend Federal regulations to insure that liability for the platform would transfer to the DOI instead of the original oil and gas operators. That agency would then also be responsible for protecting the platform and the organism living on it. The DOI could then re-lease the platform to another concern. It has leased lands to mineral, forestry, and agricultural interests in the past, and they have extensive experience in leasing offshore blocks and platforms. Other Federal land legislation could be modified for the successful long-term management of platform habitats. This would also reduce the risk to alternate use users.

8.2 Initiate programs to encourage the culture of ornamental fish and invertebrates

It is possible to save some deep-water (> 30 m) platforms eligible for alternate use now. Existing regulations allow operators to start harvesting ornamental fish on the platforms. National Oceanic Atmospheric Administration (NOAA) has determined that the harvest of ornamental fish is legal in the Gulf of Mexico (NOAA 2009). It is not expensive and it requires only minor modifications to the platforms. In the past, EcoMar harvested invertebrates on the California platforms for many years (Meek et al. 2000). They provide a template for moving forward.

8.3 Examine marine invertebrates on the structures for presence of pharmaceutically valuable natural products

Sammarco and Coll (1992) found that some scleractinian corals and octocorals, which may be found commonly on platform, possess bioactive natural products, including anti-viral compounds. Rouse (2009) investigated five offshore platforms and found pharmaceutically valuable organisms on all of the structures. Additional research is required to clarify the valuable biotic assemblages. If mariculture techniques were instituted properly and successfully—and in a sustainable manner, they could provide access to bioactive compounds that would otherwise be illegal to harvest.

8.4 Create a sustainable fisheries (sea farms) program in US federal waters

Promote a sea farming program utilizing methods similar to those practiced in Japan (Sheehy 1981; Kaeriyama and Edpalina 2004; Adrianto et al. 2005). There are currently no such programs in Federal waters of the Gulf of Mexico. We recommend that the US Dept. of Commerce—NOAA and related state agencies focus on a sustainable fishing strategy that preserves these habitats and consider methods to harvest the fish and invertebrates in a sustainable manner.

9 Conclusion

There used to be ~4000 offshore fixed platforms and now there are ~1800 and based on an average lifespan of 17 years, there will be ~200 in 10 years. The proposed fishery methods are a major shift from traditional predatory fishing; however, these sustainable approaches may preserve the platforms and generate new revenues and jobs. Amending existing relevant regulations (30 CFR 285.1000 Subpart J) could help us to recover stranded oil and gas resources, and comply with U.S. Federal environmental, energy, and fisheries regulations.

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