OFFSHORE OIL PLATFORMS: AN INVALUABLE ECOLOGICAL RESOURCE

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Abstract

Hard substrates created by oil platforms in the Gulf of Mexico and Santa Barbara Channel provide a significant portion of the hard bottom habitat that is essential for the encrusting organisms that form the base of a complex food web. These substrates, the platforms' high profile and open structure, and their creation of excellent habitats and breeding grounds from the sea floor through the splash zone expand the numbers, diversity and range of many desirable fish, shellfish and other organisms.

The presence of 20-50 times more fish under and around a platform than in nearby soft bottom areas acts as a strong lure for sport anglers, commercial fishermen and sport divers. Mariculture has also become an important activity.

The current requirement that platforms be entirely removed once production operations have ceased threatens to cause the loss of many habitats. However, it has also spawned a rigs-to-reefs movement, whose goal is to convert a number of the platforms into permanent artificial reefs.

INTRODUCTION: HABITAT CREATION

For most people, offshore leasing means energy and revenue production. Indeed, during 1985, America's offshore platforms produced enough oil to run 35 million cars and enough natural gas to heat 50 million homes for the entire year. Since its beginning in 1954, the Federal Outer Continental Shelf or OCS leasing program alone has generated over 7 billion barrels of oil, 70 trillion cubic feet of natural gas and 80 billion dollars. (10)

Rarely does offshore oil suggest fish, fishing, scuba diving or national parks. However, almost \$5 billion in Federal offshore leasing revenues have gone into buying and improving recreation areas, like Redwoods National Park, Gateway National Recreation Area, the Channel Islands Marine Sanctuary and numerous state and local parks and facilities. More importantly to ocean users, by acting as artificial reefs, offshore petroleum production platforms greatly improve marine habitats and carrying capacities, fish and shellfish populations, and sport and commercial fishing, maricultural and scientific opportunities.

With but a few exceptions, America's coastal and ocean waters are extremely rich in nutrients.

Currents, like those that arc into the Gulf of Mexico from the Western Caribbean and South Atlantic, also bring larval and juvenile stages of numerous fish and invertebrates. These undeveloped progeny of corals, sponges, brittle stars, nudibranchs, hydroids, anemones, fish and shellfish float in the currents until they find a suitable habitat -- or until they die.

For plants and animals that require a hard substrate the texture, contour and angle of the prospective surface are determinants of suitability, as are the amount of sunlight reaching it and the strength and direction of currents. Also important is whether the surface is already host to the same species, or to algae or other sources of food, since resident organisms give off chemicals that can signal whether the surface is suitable. Another critical factor is the larva's lifespan, which can range from a few hours to a few weeks.

Each time it contacts a potentially suitable surface, the spat chemically tests the substrate. If the surface passes muster, the spat glues itself down, metamorphoses into adult form and begins to grow and propagate. (2, 11, 13, 16)

However, coral reefs and rocky hard bottoms are quite rare off our coasts. The Mississippi River alone carries 250 million tons of sediment a year into the Gulf of Mexico; four California rivers empty 20 to 80 million tons of sediment into the Santa Barbara Channel every year. As a result, off all our coasts, most ocean bottoms are vast, featureless expanses of mud and sand -- oceanic deserts that provide little habitat diversity, have low carrying capacities and thus support only limited life. (8, 9)

To improve this situation, Americans have been experimenting with artificial reefs since the early 1800s. World War II "Liberty Ships" have been sunk, as have tires, railroad cars, concrete culverts and even computer hard disks. Miami has a "Mercedes" (a freighter that washed up on a beach in 1985), and Palm Beach has a Rolls Royce -- courtesy of a slightly eccentric donor who was miffed that Miami had gotten a Mercedes.

However, the biggest and best artificial reef system in the United States, perhaps in the world, is off the coasts of Louisiana and Texas -- some 4,050 oil and gas production structures (also called rigs or platforms). California has about 30 platforms. Most of the Gulf of Mexico structures

are in relatively shallow waters, but many stand in 400-1,000 feet of water, and several are taller than the Empire State Building. Many of the California platforms are in 400-900 feet of water.

What makes them work so well is the complex network of underwater support columns and braces, known as the "jacket." The jackets are surprisingly similar to some of the best midwater artificial reefs developed by Japan, which spends \$100 million to \$300 million annually on the development, construction and siting of artificial reefs. (11)

These "jackets" rise up through the entire water column, from the sea floor through the splash zone. A single platform standing in 200 feet of water provides about 2 acres of hard substrate, without which algae, sponges, hydroids, corals, barnacles, anemones, mussels and many other species could not exist. These "encrusting" or "biofouling" organisms quickly colonize the jacket, forming the base for a remarkably complex and abundant food web.

A typical offshore platform and jacket

It has been estimated that production platforms provide some 28 percent of all the known hard bottom habitat in the Central and Western Gulf of Mexico. In Louisiana waters less than 300 feet deep, oil and gas structures probably account for over 90 percent of all the hardbottom habitat. The Gulf of Mexico Fishery Management Council has estimated that 2,000 of the region's largest

platforms create some 5,000 sq. km. (1,900 sq. mi.) of artificial reef habitat. (3, 15)

The platforms provide benthic, midwater and upper water habitats, allowing species to expand their normal ranges and exist where they had been unable to previously. They also increase local carrying capacity and biomass. Several factors are crucial.

First, the platforms' open structure allows fish, as well as plankton and other nutrients, to circulate freely. Second, the steel reefs provide hard substrates in the upper 30 to 90 feet of the water column, where sunlight assures maximum algal growth, greatly increased primary productivity and ample supplies of plankton for barnacles and other filter feeders. Large populations of encrusting organisms flourish in a new "mini-ecosystem," providing food, shelter and excellent breeding grounds for numerous small fish and invertebrates.

Third, the platforms' size and high relief attract fish (which are thigmotrophic); provide reference points for fish; and supply shelter from currents and predators. Snapper, grouper and many other species become permanent residents. Bluewater platforms in the Gulf of Mexico host a wide array of tropical ornamentals.

Of course, platforms -- like any other reef -- also attract and concentrate many fish that do not depend on the reef, but are attracted to it by its high profile and potential for prey. The large schools of scad, sardine, menhaden, lingcod and blue runners are good examples, as are the major predators, like cobia, amberjack, bluefish, shark, mackerel, dolphin, barracuda and billfish.

In summary, platforms do more than merely concentrate fish. By creating new ecological niches and increasing an area's carrying capacity, they also expand the size, range, numbers and diversity of highly desirable fish and shellfish. Moreover, they do this without reducing fish populations at other natural or artificial reefs. As biological succession progresses, any fish recruited to a platform from other reefs or hardbottom areas are replaced by fish that otherwise would have been lost to predation and other biological processes. The earlier habitat soon returns to its original carrying capacity and population levels. (1, 3, 10, 11, 13, 16, 20, 22, 23)

PLATFORM COMMUNITIES

In both the Gulf of Mexico and Santa Barbara Channel, 20 to 50 times more fish can be found under and near platforms than in nearby areas with soft bottoms; two to five times more fish have been observed around platforms than at nearby natural hard bottom sites. Gulf platforms boast both tropical characteristics (high species diversity, low numbers per species) and temperate traits (low diversity, high populations of an individual species). (11, 16, 20, 22, 23)

Biological succession proceeds from the platform's installation until a complex reef-type system is established, usually in five to six years. Food,

shelter and plant/fish/invertebrate biomass increase rapidly as the platform reef is colonized, then tapers off somewhat in both species and numbers as carrying capacity is achieved. (13, 16)

A wide variety of factors determines species composition and numbers, growth rates and productivity levels on a given platform reef. One factor is the platform's age and which species were spawning or in the area when the platform was installed; this may determine whether a particular ecological niche is available or is already occupied by the time a new species arrives. Other major factors involve the platform's location, which determines weather, salinity levels, suspended sediment levels and the presence of fresh water from major rivers; current speed and direction; the amount of substrate available; distance from shore; water depth and temperature; and, of course, the species characteristic to the area: Pacific forms or the Caribbean, South Atlantic and Gulf of Mexico species common to Texas and Louisiana waters. (7, 11, 16, 20, 22, 23)

Changes in species and numbers also occur diurnally and seasonally. Hydrozoans die back significantly on Texas and Louisiana platforms in summer months, for example, causing a 50% decline in biomass. The presence of redfish, bluefish, pompano and other species also changes daily and seasonally. (11, 16, 22)

In the Santa Barbara Channel and other California waters, swift, algae-laden currents create astonishingly rich environments beneath the platforms. Mussels grow up to three and four feet thick on jackets and conductor pipes, large schools of rockfish and other fish are common, and barnacles, *Corynactis* and *Metridium* anemones, sponges and gorgonians cover entire platform legs. Rock crabs, nudibranchs, scallops and other invertebrates are also common. Several platform specimens of the giant starfish *Pisaster giganteus* have measured over 30 inches across. (1, 11, 22)

California sea lions can be found on buoy barges, a floating oil pipeline at the "offshore storage and treatment" vessel and even the platform itself at Exxon's "Hondo" production complex off Santa Barbara. Even Union Oil Company's Platform A, where the infamous blowout occurred in 1969, is now a thriving ecosystem, inhabited by numerous rockfish and other animals.

The accompanying table summarizes species common to Gulf of Mexico platforms, grouping them roughly by water depth. (3, 11, 16, 20) Communities can also be grouped by distance from shore (coastal, estuary, offshore and bluewater assemblages) or by species type (primary energy producers, filter feeders, foraging fish and invertebrates, scavengers, and resident and transient predators).

FISHING, DIVING AND MARICULTURE

Fishing and diving the Gulf's oil rigs are major recreational pursuits. Various studies have estimated that 70% of all saltwater fishing trips greater than 3 miles from the Louisiana coast -- and over half of all offshore fishing trips from the Freeport-Galveston area -- are to oil and gas structures. One charter boat skipper says he takes 10,000 sport anglers a year to the rigs and measures a day's success by how many coolers are filled with fish. Licensed sport anglers fishing the rigs contribute upwards of \$200 million a year to the Louisiana economy. (7, 11, 13, 25)

REPRESENTATIVE GULF OF MEXICO PLATFORM COMMUNITIES ACCORDING TO WATER DEPTH

Surface-35 Feet	35-90 Feet	90-150 Feet	All Depths	Cuttings Pile
Sheepshead	Sheepshead	Red Snapper	Barracuda	Soapfish
Atl. Spadefish	Atl. Moonfish	Gray Snapper	King Mackerel	Red Snapper
Lookdown	Lookdown	Triggerfish	Amberjack	Seatrout
Atl. Moonfish	Redfish	Croaker	Sand Shark	Croaker
Redfish	White Trout	Grouper	Hammerhead Shark	Catfish
Speckled Trout	Seabass	Tomtate	Cobia	Grouper
Sgt. Major	Bluefish	Catfish	Dolphin	Shrimp
Spanish Mackerel	Tangs	Creole Fish	Tuna	Spiny Lobsters
Hardtail	Butterfly Fish	Angel Fish	Crevalle Jack	Crabs
Blennies	Damselfish	Wrasses	Bryozoans	Gorgonians
Seabass	Angel Fish	Spanish Hogfish	Hydrozoans	Bryozoans
Sardines	Squirrel Fish	Shrimp	Polychaetes	Starfish
Pompano	Blue Runner		Anemones	Polychaetes
Cocoa Damselfish	Creole Fish		Sea Cucumbers	Sea Cucumbers
Tangs	Croaker		Starfish	Anemones
Butterfly Fish	Drum		Spiny Lobsters	
Stone Crabs	Crabs			
Clams	Clams			
Oysters	Oysters			
Amphipods	Scallops			
Pistol Shrimp	Nudibranchs			
Nudibranchs	Hard/Soft Coral			
Pistol Shrimp	Gorgonians			
Brittle Stars	Fireworms			
Hard/Soft Coral	Sea Cucumbers			
Sponges	Algae			
Algae				
			On Mud Bottom	Surface & Platform
			Flatfish	Gulls
			Catfish	Terns
			Speckled Trout	
			Tube Worms	
			Polychaetes	

Some have expressed concerns that oil platforms interfere with trawling. However, even a large platform takes up only a few acres. Off California, in an area of several million acres, there are 15 platforms in state waters and 16 in federal waters; of the federal (OCS) platforms, only a couple are in or near important trawling areas. The Gulf of Mexico's 4,050 platforms are likewise scattered over many millions of acres. This leaves extensive acreage available for trawling.

Second, trawling in Southern California accounts for only a small portion of the fish caught. In 1984, only 5% of the 310 million pounds (6% of the \$119 million landed value) of the fish landed in the ports of Santa Barbara, San Pedro and San Diego were caught by trawling. Almost 68% of the landed value for these three ports was tuna. (24)

Third, commercial fish landings in the Gulf of Mexico have gone up steadily since offshore oil production began: from 571 million pounds in 1950, to 1,698 million pounds in 1970, to a record 2,500 million pounds in 1985 -- even as the number of platforms rose from a few hundred to over 4,000 in the same period. Although much of the Gulf catch is menhaden, it also includes 80% of the nation's shrimp harvest, 39% of its oysters (both by weight)

and significant commercial hauls of drum, seatrout, pompano, snapper, grouper and mackerel. Commercial hook-and-line boats come all the way from Florida to land some \$2 million a year in snapper, grouper and mackerel from Louisiana rigs. Shrimp boats with special mud gear trawl for shrimp right along pipeline trenches. Quite clearly, oil development has not adversely affected either fish habitats or commercial fishing. (5, 11, 15, 24)

Fourth, Ecomar Marine Consulting is now harvesting over 7,000 pounds of succulent mussels a week from Santa Barbara Channel platforms, for sale to restaurants in a half dozen states. The company expects to do a \$600,000 business in 1986 and reports that platform mussels grow about four times faster than those in nearshore waters. It is also experimenting with culturing scallops and oysters under the rigs. (16, 21, 22)

Last, over half the oil yet to be discovered in the United States will be found offshore, much of it off California, where there are more untapped oil reserves and more attractive prospects than anywhere else in the U.S. The Interior Department calculates that 4 billion barrels of recoverable oil could be present off the California coast -- enough to fuel all the cars in the Golden State for 20 years; industry puts the potential much higher. Fishery concerns must be addressed in the context of national (and fishing industry) energy needs.

Dive shops in Houston, New Orleans and other cities run regular trips to the rigs, where underwater photography is a popular pasttime. For spearfishermen, primary target species include red snapper, seatrout, grouper and red drum. Other divers finance their trips or stock their saltwater fish tanks, by collecting tropical species.

A wide variety of blenny fish inhabit barnacle shells; at least one species, the razzle-dazzle or orange-spotted blenny (*Hypsoblennius invemar*) was unknown to science before it was spotted under a Louisiana rig. Angel fish, wrasses, tangs, butterfly fish and other tropicals abound, as do spiny lobsters, bristle worms and numerous species of sea anemones, corals, sponges and brittle stars.

Even the cuttings piles and shell/hash mounds under platforms are popular habitats for snapper, grouper and other species. The mounds and surrounding area are continually nourished by eggs, shellfish, leftovers from piscine meals and fecal pellets that rain from the jacket above. (1, 11, 22)

DRILLING FLUIDS: FACTS AND PERSPECTIVE

Several recent articles have raised anew the charge that drilling fluids used to lubricate drill bits and control downhole pressure are highly toxic. One stated that 900,000 tons of these fluids will be discharged into the Santa Barbara Channel (SBC) during the next 16 years; that drilling fluids "completely block" the ability of mussels, abalones and scallops to find suitable habitats; and that these discharges could destroy major fisheries and mean "entire generations of shellfish could fail to materialize." (17)

These claims are contradicted by numerous studies by the National Academy of Sciences, universities, industry and others, who have concluded that drilling fluids are not toxic under natural marine conditions. Indeed, by weight, a typical mid-density drilling mud is about 55% water and common bentonite clay; 38% barium sulfate or barite (administered to patients by doctors taking intestinal x-rays); 4% drill cuttings; 1% each lignite and chrome lignosulfonate; and 1% other compounds, none of which is toxic in the amounts involved in drilling operations. (9, 12, 14)

Often quoted in the news articles is Dr. Daniel Morse, a University of California/Santa Barbara molecular biologist and mariculturist. However, his papers and statements suggest that he is not familiar with the extensive work already done in the areas of drilling muds, metals metabolism and marine toxicology. Moreover, his experimental design was flawed, and his studies did not actually evaluate drilling fluids, or even actual drilling fluid components.

Dr. Morse tested his chemicals separately, rather than together and in the presence of barite and bentonite clay. When used in actual drilling operations, the clays and chemicals are heated together by the action of the drill bit. This bonds the chromium tightly to the clay particles, takes the chromium out of solution and greatly reduces its bioavailability.

Moreover, he used the wrong chemicals: barium chloride instead of barium sulfate, for example. The chemicals he used are more water soluble, more biologically available, more toxic and more likely to impair chemosensors than those actually used in drilling fluids. He also tested and raised concerns about several other chemicals that either are not used in drilling fluids or are not permitted for use off California: eg, No. 2 fuel oil (diesel oil), paraffin oil and ammonium.

Dr. Morse's claim that drilling fluids "completely block" the substrate testing ability of sessile mollusks is further contradicted by the widespread presence and rapid growth of mussels and barnacles under the platforms themselves. Tests by the U.S. Food and Drug Administration and the California Department of Public Health have found that the meat from mussels harvested beneath Santa Barbara Channel production platforms contains less oil, chemical, bacterial and other contamination than do mussels taken in Bodega Bay, the state's cleanest bay. The presence of coral (a highly sensitive indicator species) on nearly all Gulf of Mexico platforms also supports findings that drilling fluids are not toxic. (9, 12, 14)

As the National Academy of Sciences has noted, concerns over drilling muds also fail to consider other, far more significant sources of pollutants, like rivers and wastewater treatment plants. The Santa Ynez, Santa Maria, Santa Clara and Ventura Rivers alone carry an average of 672 million tons of sediment into the SBC every 16 years -- along with tens of thousands of tons of pesticides, herbicides, fertilizers, soil conditioners, oil,

heavy metals, industrial chemicals and untreated sewage. The 88 wells drilled in the channel during 1984 (versus 16 in 1985) deposited drilling fluids equal to twice the thickness of a hair above the eye of a common housefly, if spread evenly across the Santa Barbara Basin. During an average year, rivers deposit the equivalent of 700 years' worth of drilling mud discharges at 1984 rates. (8)

The Los Angeles Joint Wastewater Treatment Plant alone empties 48,000 tons of suspended solids into the SBC in an average year, or 765,000 tons every 16 years. At average 1985 rates, the 16-year discharge from the LA Joint facility also includes 880,000 barrels of oil and grease; 73,000 tons of phosphorus; 120 tons of arsenic; 45 tons of cadmium; 700 tons of chromium; 1,680 tons of zinc; and 100 tons of selenium. By contrast, even at 1984 drilling rates, metals in drilling muds would be measured in pounds, rather than tons. (4)

Similarly, concern over drilling muds in the Gulf of Mexico must be tempered with the recognition that the Mississippi and eleven other rivers annually deposit some 300 million tons of sediment, 1.8 million barrels of oil and thousands of tons of chemicals, pesticides and trace metals. (9)

RIGS-TO-REEFS

Existing laws and regulations require that oil and gas structures be removed once they are no longer producing petroleum. Already in mid-1985, well before the price of West Texas Intermediate Crude plunged to less than \$15 a barrel -- it was estimated that 1,700 producing structures would be removed during the next 15 years, at a cost of well over a billion dollars. (6, 18)

The vast majority will be off Louisiana. Indeed, over 50 percent of that state's nearshore hard-bottom habitat will be gone by the end of the century, unless some of the rigs can be converted to permanent steel reefs. The impact on habitat availability, on the size and diversity of fish and shellfish populations, and on recreational opportunities will be significant.

However, this potential loss has spawned a growing "rigs-to-reefs" movement. Federal regulations are being changed, so that platform removals can be reviewed on a case-by-case basis, and a number can be converted to permanent artificial reefs: left erect on site, toppled on site, hauled to new locations or disposed of in deepwater "graveyards."

Several retired structures have already been converted to reefs on a trial basis. A huge Exxon subsea production template -- some 50 feet high and weighing 1,200 tons -- was sunk in 1979 off Carabelle, Florida; the Florida Department of Natural Resources has called it "the best fish producer" in its entire artificial reefs system. Other rigs sunk off Gulf states have quickly become popular fishing and diving sites. (6, 11, 16, 18)

However, significant problems remain. Turning platforms into artificial reefs is expensive, especially if they have to be transported long

distances: from \$1 million each in waters up to 100 feet deep, to at least \$15 million each in waters deeper than 400 feet. Thus, issues of tax and other incentives must be addressed, and acceptable methods must be found for measuring the economic value of an artificial reef. There are also unresolved questions of liability for damages or injuries during or after conversion into a reef, as well as questions about responsibility for maintenance. Concerns also exist over interference with surface navigation, Navy submarines and coastal acoustical defense systems. (6, 18)

However, several developments offer encouragement that the current difficulties will be resolved in the near future. A new national artificial reefs law -- Title II of the National Fishing Enhancement Act of 1984 -- places the primary responsibility for encouraging artificial reef development with state governments, sponsoring organizations and permit applicants, like the oil companies. (18)

Some 3,600 of the nation's 4,100 offshore structures are off the Louisiana coast; over half of the state's nearshore structures (those most accessible by sport fishermen and divers) will be gone by the year 2000; and other states have expressed strong interest in acquiring them. Recognizing this, the Louisiana legislature has passed an artificial reefs bill and is using part of its share of federal Wallop-Breaux funds to develop an artificial reefs plan. Other states (Alabama, Florida, Mississippi and Texas) are also pursuing a variety of approaches to resolve issues noted above.

The National Research Council's Marine Board has recommended that the Interior Department take a lead in removing unnecessary constraints on the conversion of retired production platforms into artificial reefs. (6) The Minerals Management Service is continuing work on rigs-to-reefs procedures designed to encourage the conversion of selected OCS structures to permanent artificial reefs. MMS has issued two notices seeking ways to evaluate the suitability of individual platforms and assess questions of costs, technical problems, fisheries disruptions and enhancement, and liability for safety, maintenance and damages. (19)

The Environmental Protection Agency and Departments of Commerce, Defense, Transportation and the Interior recently reached tentative agreement on a Memorandum of Understanding (MOU) on the program. The MOU is designed to protect Defense Department facilities, operations and traffic lanes; minimize risks to maritime shipping; foster fisheries enhancement; and improve commercial fishing opportunities and the marine environment.

A draft National Artificial Reefs Plan has been released by the National Marine Fisheries Service; although it devotes less than one page to oil rigs and does not fully clarify the liability and incentives issues, it is a solid beginning. Finally, the Artificial Reef Development Center of the Sport Fishing Institute has devised an "exclusionary mapping" system to identify the best prospective sites and aid in the siting of oil rigs and other artificial reefs.

CONCLUSIONS

A more vigorous and effective artificial reefs program is clearly needed. Americans are fishing more for sport and eating more seafood. More commercial fishing operations are plying U.S. waters, using more sophisticated fish finding and harvesting gear. Residential and commercial development in our coastal zones continues apace, creating a growing need for mitigation measures.

The use of active and retired oil production platforms as artificial reefs makes good sense economically and environmentally. They provide more surface area, have a higher profile, last longer and are less likely to shift position than most reef materials traditionally used in the United States. Moreover, active platforms (as well as retired structures that are sited in shallow water or allowed to reach the upper 30-60 feet of the water column) provide upper- and midwater habitats, rather than merely benthic habitats.

The benefits of platforms to the ecology, to fisheries, to commercial, recreational and scientific activities, and to local economies can be substantial. Conversely, the potential loss of thousands of these existing steel reefs -- hauling them ashore for scrap -- would be both extremely disruptive and a waste of an invaluable and irreplaceable resource. The need for thoughtful compromises on issues surrounding the embryonic rigs-to-reefs program should be obvious.

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