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Are southern California oil and gas platforms essential fish habitat?

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US federal agencies must consult with the National Marine Fisheries Service on actions that may adversely affect "essential fish habitat" (EFH). This EFH mandate coincides with recent discussions on proposed decommissioning of oil and gas platforms in southern California. While many species falling under the Pacific Groundfish Fishery Management Plan (e.g. rockfish, genus *Sebastes*) inhabit platforms, available information is insufficient for determining whether the structures are necessary to support a sustainable fishery or contribute to a healthy ecosystem, the two basic tenets of EFH. The occurrence of juvenile and large adult rockfish at some platforms suggests that they may support important ecological functions. Because rockfish show long-term population declines, further evaluation of platform ecological structure and function is warranted and should be integrated into the environmental review process.

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Introduction

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). In addition, the Act mandates Federal agencies to consult with the National Marine Fisheries Service (NMFS), a National Oceanic and Atmospheric Administration agency, on their activities that may adversely reduce EFH quality and/or quantity.

The Pacific Fishery Management Council, with recommendations provided by NMFS, amended their Pacific Groundfish Fishery Management Plan (Groundfish FMP) to include the new EFH provision in 1998. The revised FMP identified the EFH of the 82 groundfish species as all waters from the shorelines of California, Oregon, and Washington to the outer boundaries of the US 200 mile Exclusive Economic Zone (EEZ). In designating this broad geographical coverage, no specific habitat type (e.g. kelp beds, eelgrass beds) was singled out as being more important relative to other habitats for this diverse species complex.

The 27 oil and gas platforms located in state and Federal waters in southern California (Table 1) provide one specific habitat within these boundaries. These platforms, comprised of a lattice-work superstructure of pilings, beams, and pipes, support diverse fish and invertebrate populations and are considered *de facto* artificial reefs (Allen and Moore, 1976; Love and Westphal, 1990; Love *et al.*, 1994, 1999a). In addition, mussels (*Mytilus* spp.) dislodged from the superstructure form large shell mounds accentuating bottom complexity and are considered part of the platform ecosystem (Love *et al.*, 1999b). Operating platforms range from 1.9 to 16.9 km from the coastline between Point Arguello, Santa Barbara County in the north and Huntington Beach, Orange County in the south, and rest in water depths between 11 and 365 m (Figure 1).

Groundfish species associate with these platforms (Carlisle *et al.*, 1964; Allen and Moore, 1976; Love and Westphal, 1990; Love *et al.*, 1994; Love *et al.*, 1999a, b). Their presence invites the question as to whether platforms themselves can be considered EFH. This is a valid question, as Federal regulations require decommissioned platforms to be removed at the end of their productive life, a current topic of discussion in California. However,

Table 1. List of oil and gas platforms in southern California (underlined: in State of California waters; italicized: removed; distance to land in km; depth in m) and studies (Cea: Carlisle *et al.*, 1964; A&M: Allen and Moore, 1976; L&W: Love and Westphal, 1990; Lea: Love *et al.*, 1999a,b, 2001) investigating the fish assemblages at each (—: studied; : not studied).

Platform	Distance	Depth	Study			
			Cea	A&M	L&W	Lea
Irene	7.6	74				—
Hildago	9.5	131				—
Harvest	10.8	206				—
Hermosa	10.9	185				—
Heritage	13.2	328				
Harmony	10.3	365				
Hondo	8.2	256				
A	9.3	57			—	
B	9.2	57			—	
C	9.2	58				
Habitat	12.6	88				
Hillhouse	8.9	58			—	
Henry	6.9	53				
Houchin	6.6	50			—	
Hogan	6.0	47			—	
Grace	16.9	97				—
Gilda	14.2	62				
Gail	15.9	225				—
Gina	6.0	29				
Edith	14.2	49				
Elly	13.8	81				
Ellen	13.8	81				
Eureka	14.5	213				
Holly	2.9	64				—
Eva	2.9	17				
Emmy	1.9	14				
Ester	1.9	11				
Heidi						
Hope						
Hilda			—	—		
Hazel			—			

removal waivers are permitted when conservation of fish and other aquatic life is deemed necessary. Because the mandate now requires an assessment of adverse impacts to fish habitat, determining whether platforms are EFH to groundfish species represents an important step in the environmental review phase of decommissioning.

To answer this question and following US Federal regulations providing guidance for identifying EFH, I present the outcome of a review of the scientific literature pertaining to the ecological structure and function of southern California platforms relating to Pacific Groundfish FMP species. Investigations not fully documenting platform fish assemblages were omitted.

Ecological structure

The minimum regulatory requirement for EFH designation is the common presence of federally managed species. Of the 82 fish FMP species, 40 have been recorded at southern California platforms (Carlisle *et al.*, 1964; Love and Westphal, 1990; Love *et al.*, 1994, 1999a, b, 2000). Members of the rockfish family (Genus *Sebastes*) dominate the list, with 32 out of 52 federally managed rockfish documented at platforms (Table 2).

Regulations also recommend integrating residency information to assist in designating areas as EFH. Only Hartman (1987) quantified fish residency and noted that most rockfish tagged were sedentary and undertook small-scale (<10 km) movements between adjacent oil platforms and other closely situated artificial reefs. The large-scale movements made by juvenile bocaccio from platforms to distant sites up to 148 km away presented an exception.

If platforms were indeed EFH, local population parameters calculated should at least be equivalent to those measured at natural reefs. Such an evaluation of population information derived from studies comparing both habitat types is consistent with the regulations that recommend using quantitative information (i.e. density

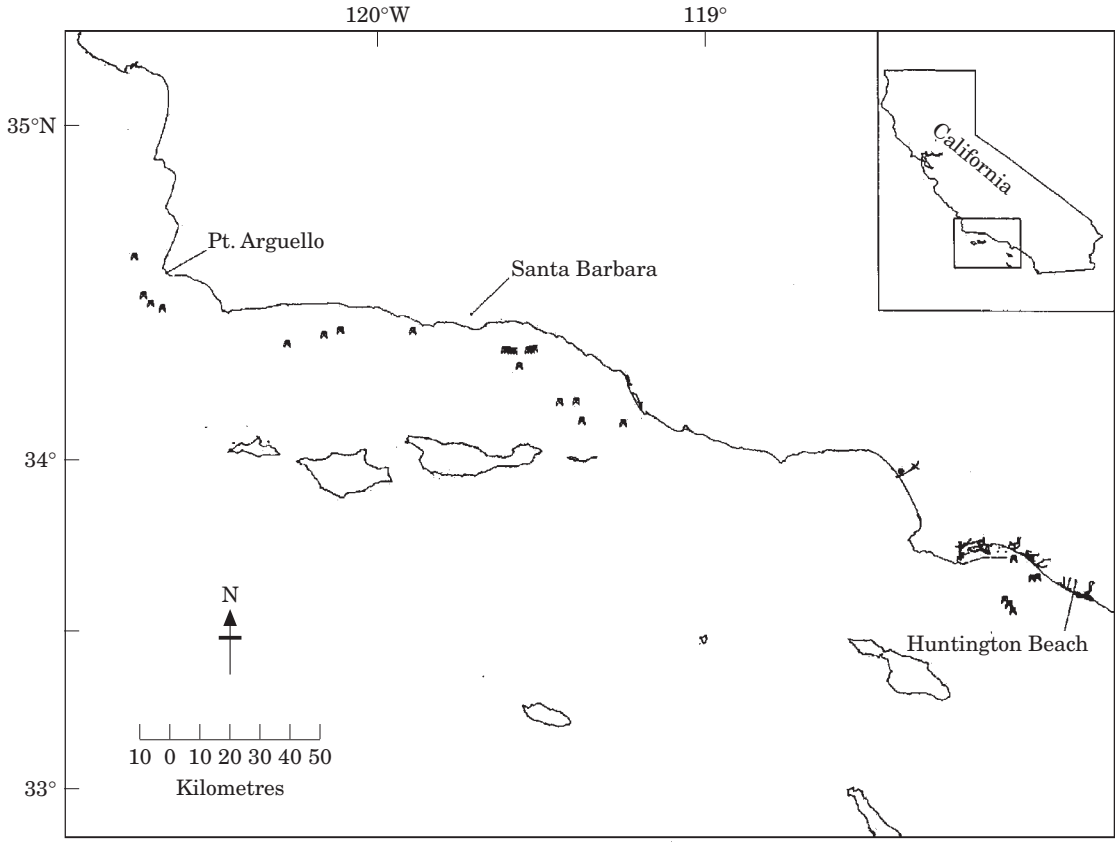

Figure 1. Location of 27 oil platforms in southern California between Point Arguello and Huntington Beach.

or relative abundance data and growth, reproduction, survival, or production rates). Three relevant studies were found (Table 3). The only parameter common to all studies was species richness and results revealed that the two habitat types do not generally differ in cumulative number of species (Love and Westphal, 1990; Love *et al.*, 2001). Love *et al.* (1999a) found five additional groundfish species at platforms relative to natural reef sites. Using a method integrating fish density, length, and site fidelity into a single habitat value statistic, Love *et al.* (1999a) calculated a percent cumulative habitat value of groundfish at nine platforms that was almost fourfold higher than the value at nine natural reefs (Table 3). Based on creel surveys, Love and Westphal (1990) obtained a c.p.u.e. at five platforms that was threefold higher than at two natural reef sites. Averaging the results of a 2-year study by Love *et al.* (2001), densities at a single platform (Hildago) were more than fourfold higher than at a single natural reef site. This large difference was primarily attributed to young-of-the-year (YOY) rockfish at midwater depths of the platform. In the same study, only slightly higher biomasses were estimated at the platform relative to the natural reef.

Ecological function

The extent to which platforms support ecological functions or services (i.e. the biological processes benefiting the ecosystem) presents an equally important topic in the EFH regulations. Ecological services were considered in the context of habitat supporting nursery, feeding, and reproductive functions.

Platforms and their surrounding mussel mounds appear to serve an important nursery function. Numerous studies report sizeable numbers of juvenile rockfishes inhabiting platforms (Carlisle *et al.*, 1964; Love and Westphal, 1990; Love *et al.*, 1994, 1999a, b), including blue, bocaccio, widow, brown, gopher, copper, black and yellow, olive or yellowtail, rosy, and honeycomb rockfishes. Because YOY rockfish are pelagic and often distributed in the top 80 m of the water column, they may be more likely to encounter a platform or settle directly from the plankton (Love *et al.*, 1999b, 2000). Love and Westphal (1990) suggest that some rockfish species may remain for a few years until they depart for deeper habitats because adults are sensitive to warmer surface waters. The studies did not specify whether similarly high recruitment occurs at natural reefs.

Table 2. Fish species managed under the Pacific Groundfish Fishery Management Plan observed at oil and gas platforms in southern California in different studies (1 – Carlisle *et al.*, 1964; 2 – Allen and Moore, 1976; 3 – Love and Westphal, 1990; 4 – Love *et al.*, 1994; 5 – Love *et al.*, 1999a; 6 – Love *et al.*, 1999b; 7 – Love *et al.*, 2000).

Common name	Scientific name	Studies
Pacific sanddab	*Citharichthys sordidus*	3,5,6,7
Dover sole	*Microstomus pacifus*	6
Widow rockfish	*Sebastes entomelas*	3,4,5,6,7
Bank rockfish	*Sebastes rufus*	5,6,7
Black rockfish	*Sebastes melanops*	2
Black-and-yellow rockfish	*Sebastes chrysomelas*	5
Blue rockfish	*Sebastes mystinus*	1,2,3,4,5,7
Bocaccio	*Sebastes paucispinis*	1,3,4,5,6,7
Brown rockfish	*Sebastes auriculatus*	1,3,2,5,6,7
Calico rockfish	*Sebastes dallii*	3,5,6,7
California scorpionfish	*Scorpaena guttata*	1,3,5,6
Canary rockfish	*Sebastes pinniger*	3,5,6,7
Chilipepper	*Sebastes goodei*	5,6,7
Copper rockfish	*Sebastes caurinus*	1,3,4,5,6,7
Cowcod rockfish	*Sebastes levis*	5,6
Darkblotched rockfish	*Sebastes crameri*	5,6,7
Flag rockfish	*Sebastes rubrivinctus*	1,3,4,5,6,7
Gopher rockfish	*Sebastes carnatus*	5,6,7
Grass rockfish	*Sebastes rastrelliger*	1
Greenblotched rockfish	*Sebastes rosenblatti*	5,6,7
Greenspotted rockfish	*Sebastes chlorostictus*	4,5,6,7
Greenstriped rockfish	*Sebastes elongatus*	1,5,6,7
Honeycomb rockfish	*Sebastes umbrosus*	3
Kelp rockfish	*Sebastes atrovirens*	1,5,7
Olive rockfish	*Sebastes serronides*	1,2,3,5,7
Rosy rockfish	*Sebastes rosaceus*	3,5,6,7
Sharpchin rockfish	*Sebastes zacentrus*	5,6,7
Squarespot rockfish	*Sebastes hopkinsi*	3,4,5,6,7
Starry rockfish	*Sebastes constellatus*	3,5,6,7
Stripetail rockfish	*Sebastes saxicola*	5,6
Treefish	*Sebastes serriceps*	5,6,7
Vermilion rockfish	*Sebastes miniatus*	1,3,5,6,7
Yelloweye rockfish	*Sebastes ruberrimus*	5,6,7
Yellowtail rockfish	*Sebastes flavidus*	3,4,5,6,7
Thornyhead	*Sebastolobus sp.*	4,5,7
Cabezon	*Scorpaenichthys marmoratus*	1,3,4,5
Kelp greenling	*Hexagrammos decagrammus*	1,5,6,7
Lingcod	*Ophiodon elongatus*	1,3,5,6,7
Pacific whiting	*Merluccius productus*	5,7
Spiny dogfish	*Squalus acanthias*	3

Habitat that supports an important prey base also provides an important ecological function. Specific information on feeding behaviour at platforms was practically nil. Carlisle *et al.* (1964) provide the only reference to actual foraging. They found empty stomachs in bocaccio rockfish but observed grass rockfish consuming white surfperch (*Phanerodon furcatus*). However, feeding opportunities appear to be extensive. Besides the presence of juvenile rockfish, forage prey such as coastal pelagics [e.g. sardine (*Sardinops sagax*), northern anchovy (*Engraulis mordax*) and jack mackerel (*Trachurus symmetricus*); Love *et al.*, 1999a] and rich invertebrate populations (Carlisle *et al.*, 1964) are common to platforms.

The extent to which habitat supports a spawning stock presents another way to view ecological function. This function depends not only on the number but also on the size distribution of mature individuals as female egg production increases with increasing body size in fish (Peters, 1983). While fecundity information was not reported, some notes on fish size have been made. Love *et al.* (1997) documented that larger rockfishes (>20 cm) tended to associate with platforms and are often absent from natural reefs, suggesting that greater reproductive potential may exist at some platforms. This may result from intense commercial and recreational fishing pressure on all natural reefs in southern California (Love *et al.*, 1997). In contrast, fishing mortality may be less of

Table 3. Comparison of groundfish community metrics (number of sites in parentheses) at platforms (p) and natural reefs (r) in southern California according to three studies (with indication of sampling methods used).

	Study					
	Love *et al.* (1999a) (SCUBA)		Love *et al.* (2001) (Submersible)		Love and Westphal (1990) (Hook and line)	
Parameter	p(9)	r(9)	p(1)	r(1)	p(5)	r(2)
No. of groundfish species	24	19	15	16	20	20
% Habitat value[a]	28.9	7.6				
Relative density (# m^{-2})			16.9	3.7		
Biomass (g m^{-2})			274	253		
C.p.u.e. (# h^{-1} angling)					0.3	0.1

[a]Index based on the product of density, mean size, and frequency of occurrence.

a factor at operating platforms as many fishing vessels do not venture in their close vicinity because of safety concerns. The presence of larger-sized fish at California platforms concurs with the observation at North Sea platforms that some species appeared to be larger compared to the open sea (Aabel *et al.*, 1997).

The question of EFH

The review of fish community structure clearly indicates that species composing the Groundfish FMP form the dominant group at the platforms investigated. The presence of this complex meets the presence/absence criterion for identifying habitats as EFH. However, the literature also indicates that community metrics at platforms do not consistently exceed those at natural reefs. Further, owing to unique variations in community structure among platforms (Love *et al.*, 2000), possibly related to depth and location, patterns explaining how community structure may be environmentally regulated at platforms have yet to emerge. This may be partly due to the relatively short (5-year) time-frame covered by the studies. In addition, 11 of the 27 platforms, including three of the deepest ones, have yet to be examined (Table 1). While the consistent presence of YOY and older rockfish, and even occasional sightings of some large rockfish up to 48 cm (Love *et al.*, 2000), suggest that platforms may support nursery and potentially spawning habitat, the data are insufficient to definitely conclude that it is EFH as defined by the statute. Consequently, the question of platforms supporting a sustainable fishery or contributing to a healthy ecosystem, the two basic tenets of the EFH definition, remains unsettled.

Avoiding Type I error

As the debate over platform decommissioning proceeds, an obvious question is whether the significance of platforms as EFH should be scientifically pursued. Admittedly, their contribution to total hard-bottom habitat within the southern California Bight is proportionally insignificant. However, this may be an improper way to consider their value. Roberts and Polunin (1991) note that the total reproductive output of small habitats harbouring larger females conceivably could be as productive as much larger areas harbouring smaller females. This possibility becomes even more important when considering that over 12 rockfish species are known to produce multiple broods per season (Moser, 1967; Love *et al.*, 1990). The generally higher availability of larger fish within areas restricted to fishing relative to surrounding open areas is well documented (Dugan and Davis, 1993; Polunin and Roberts, 1993; Rowley, 1994; Roberts, 1995). The prevailing theory is that such areas may serve as a recruitment source by exporting eggs and larvae as well as causing a "spill-over" of older stages emigrating from protected areas to harvesting areas (Carr and Reed, 1993; Dugan and Davis, 1993; Rowley, 1994). Whether platforms contribute to regional production of groundfish species may only be evaluated by expanding science-based knowledge of platform ecology. Intensifying research should reduce the probability of making a Type I error during the decommissioning process, i.e. erroneously rejecting the hypothesis that platforms are EFH.

There is an equally compelling reason to continue platform research. Many rockfish species managed under the Groundfish FMP show steady, long-term population declines in both recreational and commercial fisheries (Love *et al.*, 1998). One reason for these declines may be the cumulative degradation of productive habitats caused by anthropogenic activities. Therefore, removal of any existing habitat may exacerbate further stock collapses, especially because platforms may be one of few remaining habitats yet to be fully exploited owing to their inherent risk of ensnaring fishing gear (Aabel *et al.*, 1997).

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