Public **Meeting/Workshop**

EFFECTS OF AN OCS OIL AND GAS PRODUCTION PLATFORM ON ROCKY REEF FISHES AND FISHERIES

Proceedings Report

MMS U.S. Department of the Interior
Minerals Management Service
Pacific OCS Region

contract 10217

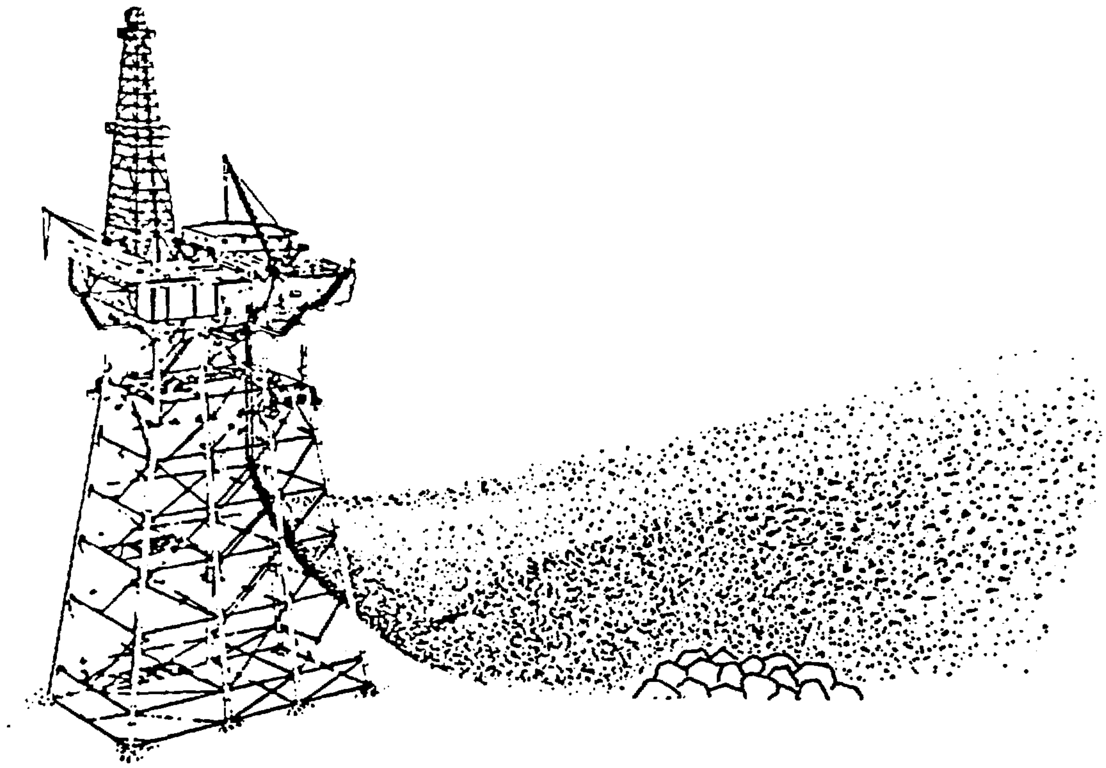
4 ⅄

Public Meeting/Workshop

EFFECTS OF AN OCS OIL AND GAS PRODUCTION PLATFORM ON ROCKY REEF FISHES AND FISHERIES

WEDNESDAY
14 DECEMBER 1988
8:00 a.m. to 5:00 p.m.

Mosher Lecture Hall
Occidental College
1600 Campus Road
Los Angeles, CA 90041



U.S. Department of the Interior
Minerals Management Service

Preface

This Proceedings *Report* summarizes the results of a public workshop entitled **'Effects** of an OCS Oil and Gas Production Platform on Rocky Reef Fishes and Fisheries,' which was held 14 December 1988 at Occidental College, Los Angeles, California. The Minerals Management Service (MMS) sponsored the workshop to receive information and recommendations on sampling methods and analytical techniques that might be applied to a study of the distribution and biology of fishes that live adjacent to oil and gas development and production Platform Hidalgo, located at a depth of 131 meters off Pt. Arguello, California, Included are summaries/abstracts of verbal presentations given by ten invited experts.

The information gained from the workshop will be used by the MMS, Pacific OCS Region in the development of Request for Proposals (RFP), to be released in early 1989,

This report is being mailed to all workshop registrants. Copies of this report may be requested from Joanne Golden, Technical Information Specialist, Minerals Management Service, 1340 West 6th Street, Los Angeles, CA. or by calling (213) 894-3379.

Gary D. Brewer
Environmental Studies Section
Minerals Management Service

John Stephens, Jr.
Biology Department
Occidental College

Table of Contents

	Page
Preface	ii
Introduction	*7*
Overview of the California OCS Phase II Monitoring Program	*2*
Hard Bottom Assemblages Near Platform Hidalgo	*9*
Quantitative Assessment of Deep Water Benthic Fish Populations: Survey Methods and Analytical Techniques	*77*
Fisheries in the Point Conception - Point Arguello Area	*13*
Feeding Habits of Fishes Associated with Offshore Oil Platforms and Adjacent Deep Water Reefs: What Can We Learn?	*15*
Quantitative Surveys of Fishes at SCUBA Diving Depths	*19*
Using Submersibles to Estimate the Abundance and Distribution of Deep Reef Fishes	*20*
An Overview of the Potential Uses of Fixed Location and Mobile Hydroacoustic Methods for the Study of Fish Populations In and Near Oil and Gas Production Platforms	*22*
An Overview of Submersible Technology and Methods	*24*
Sublethal Effects of Contaminants on Fishes	*26*
Study Potentials and Priorities	*29*
Workshop Agenda	30
Workshop Registrants	33

Introduction

Gary D. Brewer

Minerals Management Service
Pacific OCS Region
1340 West 6th Street
Los Angeles, CA 90017

The public workshop was organized by the Minerals Management Service (MMS) to receive information and recommendations for sampling methods that might be applied to the proposed Fiscal Year 1989 study entitled "Effects of an OCS Oil and Gas Production Platform on Rocky Reef Fishes and Fisheries". The proposed study site is Platform Hidalgo, located approximately 12 miles northwest of Pt. Conception, California, at a depth of 131 meters. Platform Hidalgo is one of two site-specific areas that are being studied as part of MMS's long-term environmental monitoring of the Santa Maria Basin (Science Applications International Incorporated 1986; Hyland and Neff 1988). The ongoing, comprehensive monitoring program includes measurements of many physico-chemical parameters and extensive sampling of benthic invertebrates on a regional basis; fishes, however, are not being studied,

Prior to the preparation of a Request for Proposals (RFP), MMS seeks advice on state-of-the-art techniques for assessing the distribution and biology of fishes living adjacent to Platform Hidalgo offshore to determine if any variability in the distribution or biology of the fishes is related to the proximity of the platform structure or to platform discharges.

The platform structure represents a large surface area of hard substrate that is rapidly colonized by invertebrates and becomes an attractive habitat for fishes. Fishes may be drawn to the platform and away from adjacent deep water reefs, and hence, fewer fishes may be available to fishermen who regularly target the natural reefs. Platform discharges, particularly drilling fluids and cuttings, represent a potential long-term effect on the fishes. Low level doses of metals and hydrocarbons to fishes may result in sublethal physiological and histological aberrations that ultimately result in reduced vigor, growth, or reproductive potential.

Techniques for evaluating the distribution of fishes might include direct observations, still photography and/or video via Remotely Operated Vehicles (ROVs), manned submersibles, SCUBA, hydroacoustics, fishing, and tagging. The food habits of representative taxa might provide insights into possible changes in prey availability. Potential sublethal stress associated with platform discharges might be examined through an analysis of the uptake, accumulation, and metabolism of metals and hydrocarbons.

MMS has asked the ten invited speakers and the workshop participants to consider the available information, evaluate sampling and analytical methods, and recommend study designs. Dr. Alfred Ebeling has agreed to sum-up the workshop with a perspective on *Study Potentials and Priorities.*

References

Hyland, J. and J. Neff (eds.). 1988. California OCS Phase II Monitoring Program: Year One Annual Report. Report Prepared for the US. Minerals Management Service, Pacific OCS Region, Los Angeles, CA. Volume I (MMS-87-0115) and Volume II (MMS-87-0116).

Science Applications International Corporation. 1986. Assessment of long-term changes in biological communities in the Santa Maria Basin and Western Santa Barbara Channel - Phase L Final Report prepared for U.S. Minerals Management Service, Pacific OCS Region, Los Angeles, CA. OCS Study MMS-86-001 2. Two Volumes

Overview of the California OCS Phase II Monitoring Program

Jeffrey L. Hyland

Marine Science Institute
University of California
Santa Barbara, CA 93106

The California OCS Phase II Monitoring Program (CAMP) consists of a five-year, multidisciplinary study designed to monitor potential environmental changes resulting from oil and gas development in the Santa Maria Basin region of the California OCS. This ongoing monitoring study extends the pre-drilling baseline sampling conducted in the same study area during the earlier 1983-1984 Phase I Reconnaissance Survey (SAIC, 1986). The Phase II program began in July, 1986 and is scheduled to continue through July, 1991.

The program is being conducted by a team of scientists and advisors from Battelle; Kinnetic Laboratories, Inc; University of Texas; Woods Hole Oceanographic Institution; U.S. Geological Survey; University of Maine; University of Western Ontario; Louisiana State University; Sea Space; University of California, Santa Barbara; Oregon State University; Lawrence Livermore Laboratories; and the Louisiana Universities Marine Consortium. Several independent consultants also are involved.

Specific objectives of the program are: 1) to detect and measure potential long-term (or short-term) changes in the marine environment adjacent to oil and gas platforms; and 2) to determine whether changes observed in the marine environment during the monitoring period are caused by drilling-related activities or are the product of natural processes. These objectives are being addressed through time-series monitoring of a number of environmental parameters before and after initiation of drilling at various monitoring sites throughout the study area, including control sites and sites where environmental impacts are more likely to occur. An optimal impact study design (Green, 1979) and *a priori* hypothesis testing approaches are being applied in the process of addressing these objectives, so that any conclusions regarding environmental changes can be stated within established levels of statistical confidence, The long-term nature of this program is an important feature that will help to accomplish the objective of separating natural background variation from potential low-level cumulative environmental impacts caused by oil and gas production activities such an approach to offshore monitoring has been supported strongly by various scientific advisory committees serving the marine research and management communities (Boesch and Rabalais, 1987; National Research Council, 1983).

Monitoring efforts have focused on the benthos. The emphasis has been placed here for two reasons: 1) benthic environments are suspected sinks for the accumulation of discharged drill materials; and 2) because of their relative immobility, benthic organisms should be susceptible to exposure to any drilling-related materials that may accumulate on the bottom. This emphasis should not preclude, however, related studies on other ecological components.

Specific parameters that are being addressed as **part** of the time-series monitoring effort consist of biological community indices and species abundances for hard-bottom and soft-bottom (macrofaunal and meiofauna) benthic assemblages; levels and distributions of trace-metals and hydrocarbons in bottom sediments, suspended particulate, animal tissues, and pore waters; water currents and other physical oceanographic features; and various sedimentological properties (sediment grain size, total organic carbon and carbonate content, sediment shear strength, distribution of mineral types, redox conditions, radioisotope profiles, and degrees of sediment mixing as a result of bioturbation). Synoptic measurements of these various parameters permit examination of biological changes in relation to concomitant chemical or physical changes linked to specific drilling events. Additional companion studies focus on sediment-transport processes and animal-sediment-pollutant interactions.

Thestation design for this program consists of a series of regional stations and two additional arrays of site-specific stations located in the immediate vicinity of two oil production platforms (Figure 1). The regional stations consist of three cross-shelf transects of three stations each (encompassing water depths of about 90 to 410 m) and an additional station located approximately 50 km west of Pt. Sal, in a suspected offshore depositional area, Regional stations were selected with two major objectives in mind: 1) to provide an opportunity to compare ecological conditions and potential responses to drilling-related impacts over broad regional areas and bathymetric zones; and 2) to revisit, wherever possible, previous sampling stations (e.ge., sites from the Phase I survey) to provide historical data support. All regional stations are characterized by soft-bottom benthic assemblages inhabiting relatively unconsolidated substrate.

One of the two site-specific sampling arrays is located in soft-bottom substrate offshore of Pt. Sal, at the future site for Shell Western Exploration and Production's Platform Julius (Figure 2). This sampling array is designed to examine potential near-field impacts and possible impact gradients extending outwardly from the point source of pollutant discharge. This sampling array incorporates two important features: 1) a semi-radial station pattern to help detect near-field effects that might occur in any one of several directions; and 2) an oversampling approach within a relatively confined area, to help define the spatial scale of detectable near-field impacts. This type of design was used successfully in a related offshore monitoring program conducted on Georges Bank in the vicinity of exploratory drilling operations (Battelle and WHOI, 1985). The array consists of nineteen stations that were sampled during the first year of the program (i.e., October 1986, January 1987, and May 1987). Because of the realities of drilling-schedule delays for this platform, station numbers were reduced to three (PJ-1, PJ-1 O, and PJ-I 1) during October 1987 and January 1988 sampling occasions to one station (PJ-1) beginning in May 1988.

The second site-specific sampling array is located offshore Pt. Arguello, in the vicinity of Chevron's Platform Hidalgo (Figure 3). Monitoring efforts at these sites focus on rock features inhabited by hard-bottom benthic assemblages. There are two important aspects concerning these stations: 1) stations consist of both "high-relief" substrate (defined operationally as substrate higher than one meter) and 'low-relief' substrate, so that assemblages of epifaunal organisms inhabiting both types of substrate can be monitored to compare their relative susceptibilities and sensitivities to potential impacts; and 2) for each type of substrate, stations have been positioned at varying distances away from the platform so that effects can be monitored along possible 'dose-response" gradients.

The frequency of sampling at regional and site-specific stations is designed to span four years including pre-drilling and post-drilling periods, each with seasonal intervals. The current sampling schedule (Table 1) was adopted this past year based on information indicating that drilling would begin at Platform Julius in January 1990 and at Platform Hidalgo in November 1987. Although drilling at Platform Hidalgo did begin in accordance with last year's schedule, the newest information provided at the Second Annual Progress Meeting now indicates that the earliest date for drilling at Platform Julius would be during the second quarter of 1991. To date, samples have been collected up through October 1988. Further revisions to the sampling schedule and other alternatives will be considered during the upcoming year to address the latest drilling delays.

Results of this study will be available for use in various decisionmaking steps of the California OCS Federal leasing program. Also, it is anticipated that these results will expand existing knowledge of basic oceanographic processes and ecological conditions of the central California OCS, and will provide information to help interpret results of future offshore monitoring programs conducted in other planning areas. Scientific results from the first year of the program are published in Hyland and Neff **1988.**

References

Battelle and WHOI. 1985. Georges Bank monitoring program, Final Report for the third year of sampling, Prepared for U.S. Minerals Management Service, Atlantic OCS Region, Vienna, VA. Contract No. 14-12-0001-2912. Three volumes.

Boesch, D.F. and N.N. Rabalais (eds.) 1987. The long-term effects of offshore oil and gas development: An assessment and a research strategy, Report prepared for the Interagency Committee on Ocean Pollution, Research, Development and Monitoring, Elsevier Applied Sciences Publishing, Barking, Essex England.

Green, R.H. 1979. Sampling design and statistical methods for environmental biologists. John Wiley & Sons, New York, 257 pp.

Hyland, J. and J. Neff (eds.). 1988. California OCS Phase II Monitoring Program: Year-One Annual Report, Report prepared for the U.S. Minerals Management Service, Pacific OCS Region, Los Angeles, CA. Contract No, 14-12-0001-30262. Volume I (MMS-87-01 15) and Volume II (MMS 87-01 16),

National Research Council. 1983. Drilling discharges in the marine environment. National Academy Press, Washington, D.C. 180 pp.

Science Applications International Corporation (SAIC). 1986. Assessment of long-term changes in biological communities in the Santa Maria Basin and Western Santa Barbara Channel - Phase 1. Final Report prepared for U.S. Minerals Management Service, Pacific OCS Region, Los Angeles, CA, Contract No, 14-12-0001-30032. Two volumes.

TABLE 1. SAMPLING SCHEDULE

YEAR	OH-BOTTOM CRUISES	HARD-BOTTOM CRUISES
1	Oct. 86	Oct. 86
	Jan. 87	May 87
	May 87	
	July 87*	
	Oct. 87	Oct. 87
	Jan. 88	(Hidalgo Spudded: Nov. 87)
	May 88	
3	Oct. 88	Oct. 88
	May 89	May 89
	Oct. 89 (Spud Julius: Jan, 90)**	Oct. 89
	May 90	
5	Oct. 90	Oct. 90

* Samples collected for analysis of infaunal life-history properties only.

** This spud date was based on information available prior to the Second Annual Progress Meeting held October 19-20, 1988; an update at this meeting by Mr. Tom Jordan of Shell Western Exploration and Production indicated that the earliest drilling date for Platform Julius will be during the second quarter of 1991 (and more likely during late 1992).

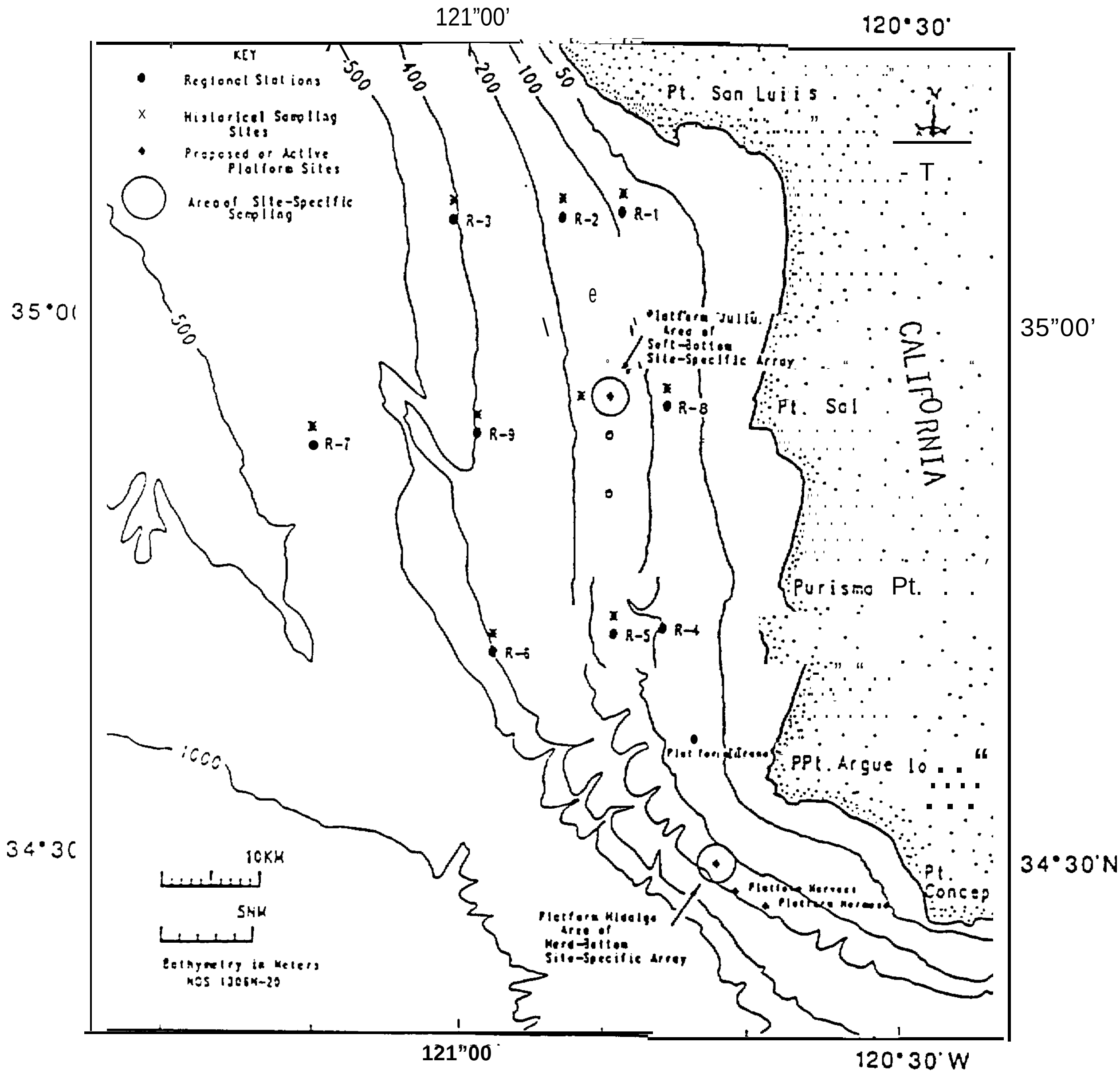


FIGURE 1. STUDY AREA AND STATION DESIGN

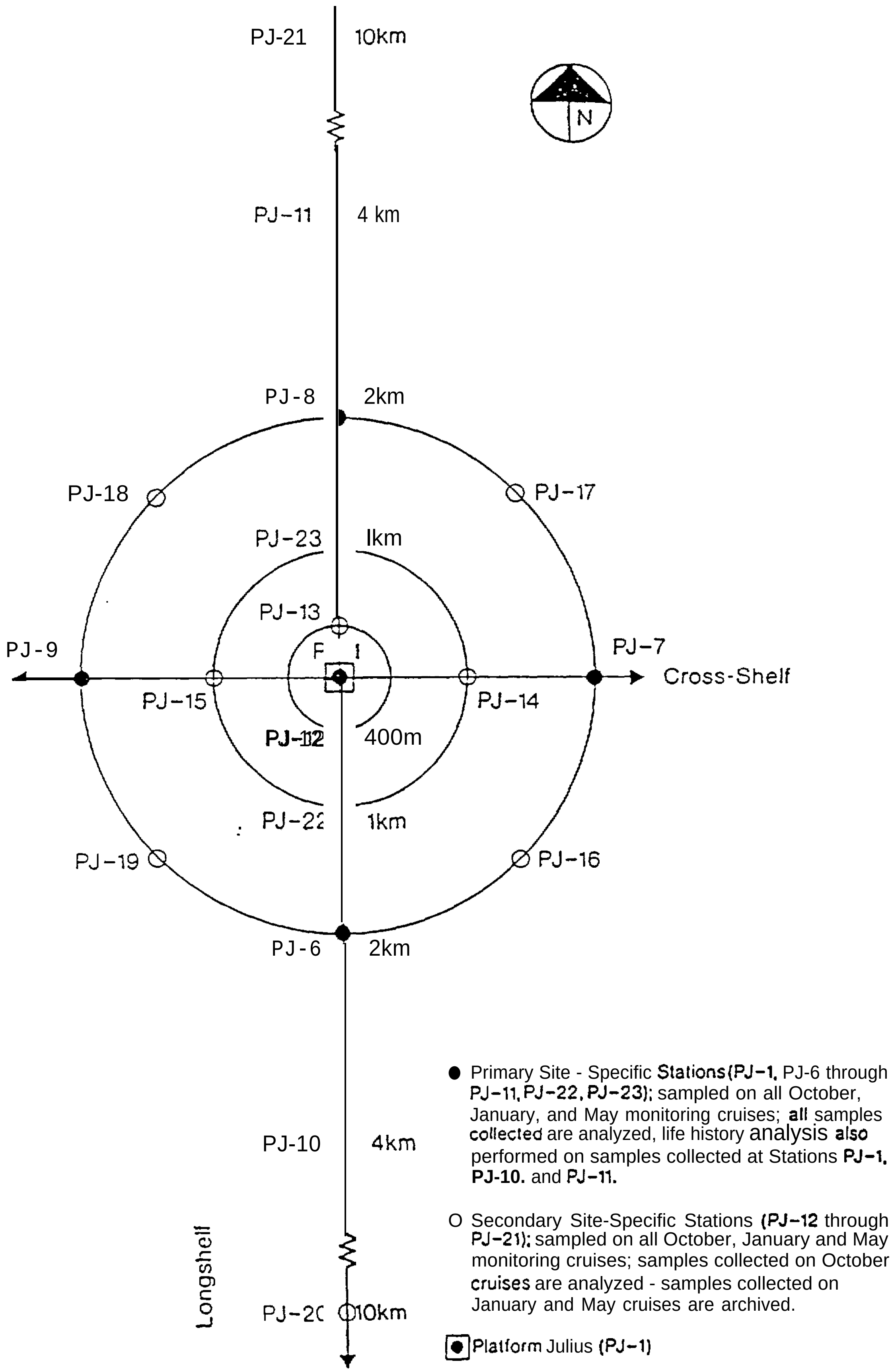


FIGURE 2. SITE-SPECIFIC SAMPLING ARRAY NEAR FUTURE SITE FOR PLATFORM JULIUS

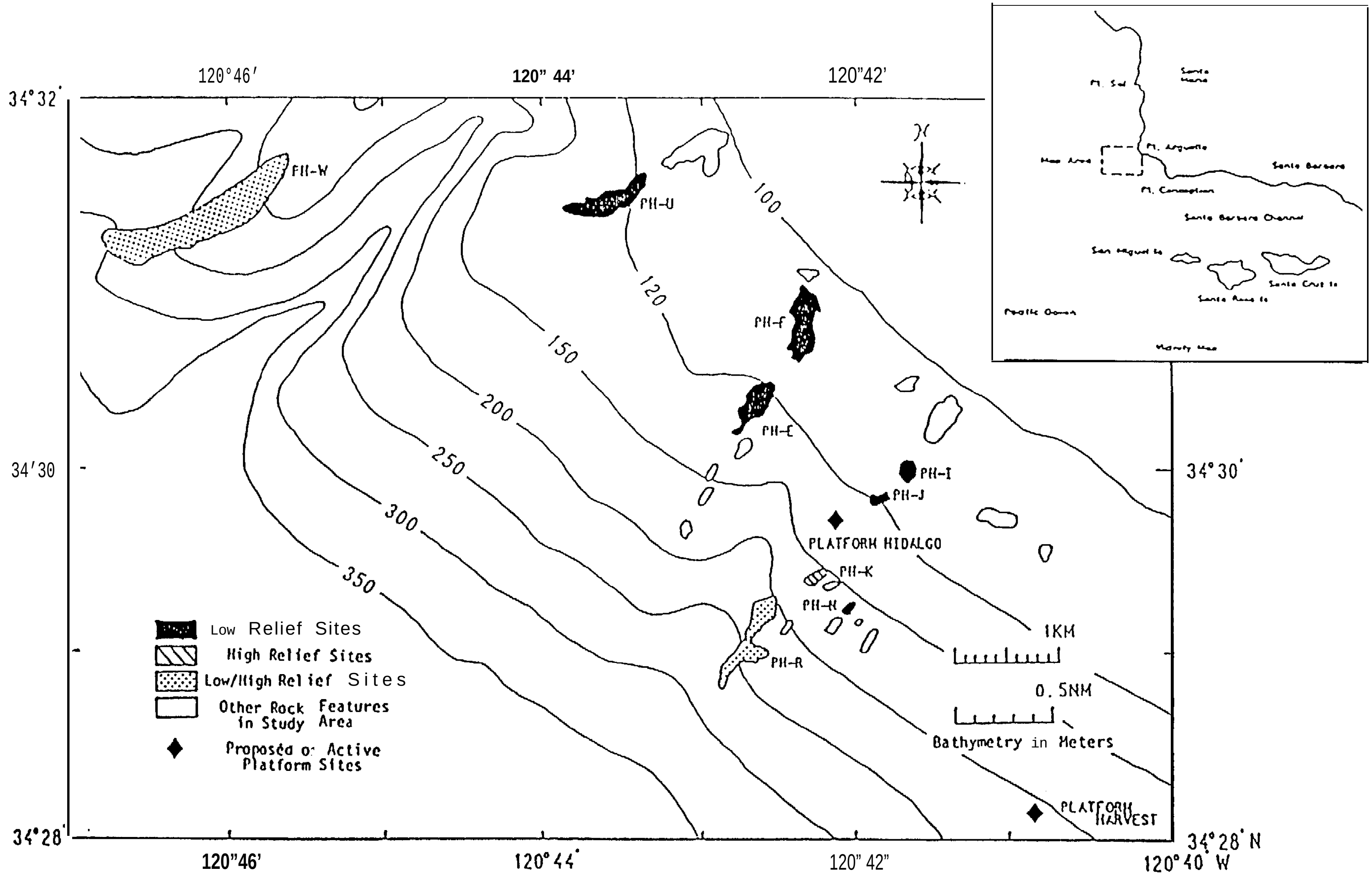


FIGURE 3. SITE-SPECIFIC SAMPLING STATIONS NEAR HARD-BOTTOM FEATURES IN VICINITY OF PLATFORM HIDALGO

Hard Bottom Assemblages Near Platform Hidalgo

Terry Parr

Kinnetic Laboratories, **Inc.**
5225 Avenida Encinas
Suite H
Carlsbad, CA 92008

Four sets of photoquadrat samples have been collected off Pt. Arguello, in the vicinity of Platform Hidalgo since the beginning of the MMS OCS Phase II monitoring program, Sampling was conducted in fall 1986, spring 1987, fall 1987, and fall 1988. During each sampling period approximately 80 photoquadrat samples were collected randomly from each of eight rocky low-relief (0.2-0.5 m) stations and three rocky high-relief (> 1.0 m) stations Each photoquadrat consists of a 70-mm slide taken approximately 1.4 m from the rock surface to include an area of approximately 1 m^2.

Sixty photoquadrats were analyzed from each station during each of the first three sampling periods. The photoquadrats were analyzed by a random-point contact method, in which the proportion of 60 points contacted by a species is used to estimate the percent cover of that species. All percent-cover and count data were normalized to rock area.

Analysis of photoquadrats in the first sampling period suggested that the hard-bottom epibenthic communities differed among stations largely in relation to depth. Clustering of Bray-Curtis similarities between stations indicated one main group formed by shallower low-relief stations, and another formed by deeper low-relief and high-relief stations, In addition, the abundances of seven dominant taxa were significantly negatively correlated with depth. Clustering of species similarities suggested that the cup coral *Paracyathus stearnsii*, the crinoid *Florometra serratissima* and a brittle star *Ophiocantha diplasia* were characteristic of low-relief stations, although the first two were negatively correlated with depth, whereas the anemone *Amphianthus californicus*, cup coral *Desmophyllum crista-galli*, and colonial coral *Lophelia californica* were characteristic of high-relief stations, but were positively correlated with depth.

Recent analysis of 60 photoquadrats from each station in each of the first three sampling periods indicates that the spatial patterns among stations were relatively stable over a one-year period. Clusters based upon Bray-Curtis similarities among stations indicated a consistent cluster of the shallowest low-relief stations, which was separate from the deepest low-relief and high-relief stations.

Percent-cover and count data for the most abundant invertebrate species in each relief type also generally indicated stable abundances over the first three sampling periods. With the exception of *Florometra serratissima*, the means for these taxa over all the stations within each relief type were very similar in each of the sampling periods. *F. serratissima* is a **motile** species that is very patchy in its distribution, so apparent temporal variation may reflect either movement within their study area or natural spatial variation. Closer examination of the data for most of these taxa also revealed low variation among sampling periods, even within individual stations.

Bottom dwelling fishes were a regular component in random photoquadrats with overall densities on the order of one per m^2, but with evidence of significant changes in density from year to year.

Analysis of data from the first three sampling periods suggests the presence of communities that vary with depth, but that are temporally stable. Although one year is not long enough to describe long-term variation, it is apparent that the abundances of most of these species do not vary seasonally.

The coefficients of variation for seven dominant species ranged from approximately 50 to approximately 300 within their designated habitats;

thus our proposed samples size of approximately 60 replicates from the long-term monitoring is sufficient for a reasonably sensitive test for effects of drilling discharges.

Sediment traps were utilized in conjunction with hard bottom monitoring to assess relative sedimentation rates and chemical composition of deposited material as a tracer of drilling muds. Sediment trap design included low-profile concrete anchors and cylindrical traps which rise no more than 1.1 m above the seabed. Each trap is attached to the anchor by a stainless steel spring which allows is to right itself if briefly knocked over. The standard-size traps consist of butyrate tubing, 6.6 cm in diameter, with aspect ratios of 8:1. There are four traps on each anchor (array) and each trap is six diameters from its nearest neighbor on the array.

Sediment traps were deployed at 10 localities in January 1988 and were retrieved the following May. This first recovery effort was highly successful. All trap arrays but one were recovered.

Data from the May 1988 retrieval indicated that very similar amounts of material were trapped by replicate traps within each array. Typically, the coefficient of variation was 5% or less. The initial data also suggest a possible depth-related trend in the amount of material trapped, although these two stations were also the closest to Platform Hidalgo. The data also indicated that similar amounts of material were trapped far away from rock features and at comparable depths but nearer rock features,

Preliminary analyses of sediment metals concentrations indicated an influence of drilling muds at three sampling stations, Results require further interpretation and integration with information from drilling activities occurring at platform Harvest located 3 km to the southeast of Hidalgo.

Quantitative Assessment of Deep Water Benthic Fish Populations: Survey Methods and Analytical Techniques

Andrew Lissner[1], Suzanne Benech[2], and Douglas Diener[3]

[1]Science Applications international Corporation
4224 Campus Point Court
San Diego, CA 92121

[2]Benech Biological Associates
487 Lincoln Dr.
Ventura, CA 93001

[3]Marine Ecological Associates
531 Encinitas Blvd. Suite 110
Encinitas, CA 92024

Survey methods used to assess fish populations generally can be grouped into two categories: observational or collections, Observational methods include visual assessments by scientific observers, photographs, video or movie film, trapping, fishing stunning, or chemicals. All of these methods could be applied to assessments of deep water (e.g., > 30 m depth) reef fish; however, their ease of application (particularly in high relief or snag areas) as compared to methods such as trawling and the greater ability to assess how representative the data are of the overall community,

Of the observational methods, we believe that video taping is most appropriate for use in assessing deep water fish communities because (1) it provides an immediate hard copy of the sampling event; (2) the record is continuous and can be repeatedly analyzed in real time, slow motion, or frame-by-frame; and (3) the method is cost effective and can be adapted for use with manned submersibles or ROVs. A limitation of video taping is that it normally provides a relatively narrow field of view ("tunnel vision") as compared to that which can be achieved by scientific observers in submersibles having wide-range viewing ports. Data recording by scientific observers coupled with video taping (i.e., from a submersible) probably provides the best overall method for collecting representative, high quality data if there are no significant operation considerations (e.g., high winds and seas) or cost constraints.

Within the Santa Maria Basin, California outer continental shelf region there are typically severe winds and seas coupled with relatively high near bottom currents (e.g., >1 kt); these conditions often limit the use of submersibles due to restricted working time and safety considerations for personnel. We therefore recommend that a ROV configured with a video taping system is the most effective method for surveying fish populations in this offshore region. The advantages of an ROV include (1) greater safety for personnel, (2) greater ability to launch, recover, and operate under marginal wind and sea conditions, (3) essentially unlimited survey time once on bottom (power to the ROV is provided by a cable from the ship), (4) multiple observers can observe shipboard monitors in real time and record observations or make survey changes as necessary, and (5) many ROVS are more maneuverable in high relief areas.

Historical video data are available from over 75 hard substrate areas surveyed in State and Federal waters from approximately Morro Bay to San Diego (Tanner and Cortes Banks) California. This represents approximately 100 miles of video transects from which deep water fish data are potentially available. However, a rough estimate is that only 30% Of these data are frOm areas with exposed hard substrate; the remainder of the transect areas are covered with varying depths of surficial sediments, Additionally, the video quality is quite variable in resolution and areal coverage and the data primarily were collected during only one time period per site. The present level of data work-up for **the fish** from these studies is primarily species lists and estimates of relative abundances. Further, since the primary objective of most of these surveys was the benthic invertebrates, the viewing area of the video was directed at the substrate and therefore primarily recorded demersal species, However, some useful data might be obtained from these video records by first stratifying them according to depth, substrate type, geographic location, and season and then recording species presence/absence data from selected segments of the video which represent ‘sub-transects” that are of acceptable photographic (video) quality.

Fisheries in the Point Conception - Point Arguello Area

Milton Love

Department of Biological Sciences
University of California
Santa Barbara, CA 93106

Sportfishing

Party vessel fishing is uncommon in this area, due to the long runs necessary from Avila to the north and Santa Barbara to the south. However, an occasional vessei fishes for rockfishes, such as bocaccio (*Sebastes paucispinis*), chilipepper (S. *goodei*) and vermilion (S. *miniatus*), in 50-60 fathoms. Some kelp bass (*Paralabrax clathratus*) are also taken off Point Conception; white seabass (*Cynoscion nobilis*) and California halibut (*Paralichthys californicus*) are also targeted. Skiff fishermen, launching from Gaviota, fish for the same species. in particular, scuba spearfishermen work the Point Conception area for California halibut,

Commercial Fishermen

A wide variety of species are taken buy commercial fishermen in this area.

King salmon (*Oncorhynchus tshawytscha*) are targeted by trollers, over 2040 fathoms, mainly in May and June, Rockfish (*Sebastes* spp.) are taken by gillnet, hook and line and trawl from 50-1 25+ fathoms, Important species include vermilion, cowcod (*Sebastes levis*), yellowtail (S. *flavidus*) and bank (S. *rufus*) rockfishes, bocaccio and chilipepper. California halibut are taken by gillnet and trawl in 10 to 50 fathoms. There is a gillnet white seabass fishery, targeting fish which come in during squid spawning, from the keip beds to 30-40 fathoms. Angel sharks are taken by gillnet and trawl, from near the surf line to 50+ fathoms. Assorted flatfish, primarily Dover (*Microstomus pacificus*), English (*Parophrys vetulus*) and Pet rale (*Eopsetta jordani*) *soles* are taken by trawlers in 50+ fathoms over sand and mud bottoms. Occasional gillnet sets on barracuda (*Sphyraena argentea*) are made near Point Conception.

Pelagic fishes taken include bonito (*Sarda chiliensis*), caught by jib boats and purse seiners in summer and fall; Pacific (*Scomber japonicus*) and jack mackerel (*Trachurus symmetricus*) and northern anchovies (*Engraulis mordax*), all taken by purse seiners. Swordfish (*Xiphias gladius*) are caught in floating gillnets, 10-20 miles offshore and albacore (*Thunnus alalunga*) are sometimes encountered by trollers and gillnetters 30+ miles offshore.

A Comparison of Fishes taken by Sportfishing Party Vessel from Oil Platforms and Adjacent Natural Reefs

i compare the species compositions of fishes caught around oil platforms, situated in about 30 fathoms off Santa Barbara, CA, with those over adjacent rocky reefs, Rockfishes dominated the catch at all three areas. Midwater species, such as blue (*Sebastes mystinus*) and olive (S. *serrainoides*) rockfish, were abundant at all areas. Benthic species, such as starry (S. *constellatus*) and rosy (S. *rosaceus*) rockfish, were common over natural reefs, but rare around the oil platforms. On the other hand, canary rockfish (S. *pinniger*) were abundant around the platforms and uncommon or absent from the natural reefs. Juvenile rockfishes dominated the platform catches to a greater extent than in catches from natural reefs.

Breakaway Tags

While traditional anchor tags may be employed for tagging rockfishes in shallow (less than 50 fathoms) water, breakaway hook tags may be a viable alternative for tagging deep water species. Breakaway tags employ a hook to which a legend is affixed. The legend may be on a plastic sleeve attached onto the hook shank or on a sleeve attached to the hook by a piece of monofilament. Baited tag hooks are attached to a main iine by pieces of light-test monofiiament.

When the fishes strike, the light line separates, lodging the tags in the jaw. Preliminary tests show that hooks remain in place for at least one year.

Feeding Habits of Fishes Associated with Offshore Oil Platforms and Adjacent Deep Water Reefs: What Can We Learn?

Gregor M. Cailliet

Moss Landing Marine Laboratories
P.O. Box 450
Moss Landing, CA 95039

The overall objective of this paper is to discuss the feasibility of conducting definitive studies on the food habits of fishes inhabiting oil platforms and deep water reefs. The general focus is to study the functional relationship between fishes and the platforms and natural reefs that they inhabit. Similar to questions concerning artificial reefs (Ambrose 1985), we are interested in whether oil platforms merely attract fishes, enhance fish production, and/or have other, perhaps less obvious, effects on fish physiology or pollutant loads as a result of platform activities. Specific questions address: 1) The trophic roles of fishes inhabiting oil platforms and offshore reefs; 2) Differences in prey availability or utilization by fishes near platforms versus those associated with adjacent natural reefs; 3) Relative fish predation pressure on the prey of platforms versus offshore reefs; and 4) Assessment of the trophic role that oil platforms and reefs play in the abundance, distribution survival, and growth of fishes inhabiting them.

These questions can be focused on individual species, on guilds of fishes, or on the entire fish fauna as an assemblage. The way in which feeding habit studies would be designed and conducted, and the problems associated with doing them, will depend upon which combination of the three above approaches is chosen. Some information on the fish assemblages is already available, at least for shallower oil platforms and reefs, so taxonomic and trophic guilds can be proposed to facilitate planning feeding habit studies. However, certain problems associated with feeding studies will occur no matter which approach is chosen.

The first consideration is to determine which fish species will occupy and perhaps dominate the oil platform and nearby natural reef systems. From a preliminary analysis of angler catch data provided by Dr. Milton Love (University of California, Santa Barbara) from Platforms A,B, and Hillhouse (in approximately 60 m water depth) and two adjacent reefs (between depths of 44 and 74 m), we can make severai statements relative to potential fish feeding habit studies. First, the catches are dominated by rockfishes (Scorpaenidae, genus *Sebastes*). if one eliminates all fishes comprising iess than 1% by number from each of the reefs, there is a total of 16 species, 13 of which are *Sebastes*. These are dominated by *S. mystinus* (Blue rockfish, 20.1 %), S. *hopkinsi* (squarespot rockfish, 16.9%), *S. serranoides* (olive rockfish, 14.8%), S. *paucispinis* (bocaccio, 14.59'.), and S. *entomelas* (widow rockfish, 9.5%).

The trophic guilds of these dominant fishes can be reasonably predicted. At ieast three of these (blues, olives and widows) feed primarily on zooplankton and micronekton, according to feeding habit studies done on them in other places (Miller and Giebel 1973, Love and Ebeling 1978, and Love and Westphal 1981, and Adams 1988, respectively). Thus, these species might not really reflect a direct influence that oil platforms have in concentrating prey on their substrate, but rather an effect similar to that of a pinnacie or vertical protrusion of the bottom into the water column (Genin et al. 1988). Bocaccios tend to eat larger invertebrates and some fishes, while little is known about the feeding ecology of the squarespot rockfish. Of the three other dominant species, *Scomber japonicus* (the Pacific mackerel) is also primarily a water column predator, but concentrates on nekton, while *Paralabrax clathratus* (kelp bass) and *Genyonemus lineatus* (white croaker) would probably tend to prey directly on reef associated organisms. The other numerically iess important fishes in the fishery catches might also more directly prey on available organisms from the oil platforms or adjacent reefs.

Because members of this family have large swimbladders, the chance of stomach contents being regurgitated during retrieval through the vertical pressure gradient will be high. This can have serious effects on stomach content analysis, especially when fish are taken from deeper water (Bowman 1986), However, these cliff iculties can **be** overcome by bringing fish up more slowly, by fishing closer to the surface, and by sampling more fish for contents.

Fishes in the genus *Sebastes* have commonly been found to remain in the same general location, but can be attracted to newly established, artificial reefs (see among other, Matthews 1985, 1986, Solonsky 1985). For this reason, the results from feeding habit analysis might be very useful in determining the role that platforms and reefs play in providing habitat and food for these residential fishes. Thus, it is probably worth the trouble to characterize the feeding habits of the dominant fishes associating with these two offshore structures, and to couple this with tagging studies to better evaluate the trophic roles of residential fishes.

Because existing feeding habit studies of most of the fishes observed to associate with oil derricks and offshore reefs indicate they consume crustaceans, molluscs and fishes, which cannot be digested extremely rapidly, identification and enumeration should not be much of a problem. If collected shortly after eating, the prey from these predators should be fairly recognizable.

The major consideration in any fish feeding habit analysis study is sampling, and in these deeper habitats, this could pose a serious problem. One would need to sample a large number of fish of each species from each location, preferably representing at least three seasons of the year (Cailliet et al., 1986), The actual number necessary will vary depending upon how representative the cumulative prey assemblages are after sampling a test number of guts. Because the number of specimens required to characterize the feeding habits of most species will approximate 30 or so per location, season, and presumably size class, feeding habit analyses will only be possible on the most abundant species. Few of the rockfish species sampled in Love's study provided sufficient samples for comprehensive feeding habit analysis.

The easiest way to collect samples is to subsample the commercial and sport fishing catches (Love and Westphal 1981, Adams 1988). However, control of the sampling techniques is difficult and other means of collecting might be necessary. Possibilities to explore would be diver, submersible, and trap collections, possibly using anesthetics to allow collection of stomach contents or packing individual fish in bags prior to coming to the surface.

Once the stomach contents are collected, prey need to be identified and enumerated. With carnivorous fishes, problems associated with state of digestion and recency of feeding may not be much of a problem since most prey will remain in fairly good shape. However, diel periodicity of feeding of the dominant rockfish predators might influence the condition of the gut contents, Thus, collecting right after crepuscular periods, when many fish tend to be most active feeding (Adams 1988), would be likely to produce the best results. Once a sufficient number of guts per species has been studied, the Index of Relative Importance (Pinkas et al, 1976, Cailliet et al. 1986), which uses a combination of number, volume and frequency of occurrence of prey eaten would be most useful for describing prey utilization.

Then, these data would have to be compared between oil platforms and nearby reefs, using various measure of overlap, species similarity, or rank correlation analysis (Fritz 1974, Cailliet and Barry 1979, Hyslop 1980, Linton et al. 1981, Vodopich and Hoover 1981, Wallace 1981). Such a study was done by Brock (1985) comparing feeding habits of pelagic fishes associated with fish aggregation devices and those away from them. Another ideal is to identify what might be indicator prey species, which are either only available or are found only in the stomachs from fishes at one of the locations. A third idea would be to compare the total trophic spectrum utilized by fishes at the oil derricks and the nearby reefs to see what kinds of prey support the entire fish assemblages there (see Cailliet et al. 1979). Finally, it would be ideal to gather feeding data which could, coupled with distribution, abundance, movement, and biomass data, allow us to estimate the fish production associated with oil derricks and natural, nearby reefs (Allen 1982). This **would** help answer question posed by Ambrose (1 985) regarding attraction or production.

Once the feeding habits of the fish assemblages associated with these platforms and reefs are characterized and compared, answers to the first two questions (trophic roles and prey utilization of fishes from **the two** habitats) would be possible. Then, questions 3 (relative fish predation pressure) and 4 (trophic roles played by the platforms and reefs) could be addressed. This of course, is based upon the assumption that the methodology problems associated with stomach analyses of deep-dwelling fishes could be solved.

Based on my preliminary analysis of the data available, the literature on the dominant fish species occurring in these habitat, and the methodology available, I believe that the analysis of feeding habits of platform and reef dwelling fishes is worth attempting. There is good potential for obtaining interesting results on such questions as the abundance of prey necessary to support fish population or the role that fish predators play in influencing prey populations and assemblages. This is especially true considering that we have just begun to use new underwater technology, such as submersibles and their video and collecting abilities, to answer such important ecological questions.

References

Adams, P.B. 1987. Diet ow widow rockfish Sebastes entomelas in northern California, In: Widow rockfish: Proceedings of a workshop. NOAA Tech. Report, NMFS 48:37-42.

Allen, L.G. 1982. Seasonal abundance, composition, and productivity of the littoral fish assemblage in Upper Newport Bay, California. Fishery Bull. 80(4): 769-790

Ambrose R.F. 1985. Artificial Reefs, Volume 1: A Review and Analysis. Manuscript, Marine Review Committee, Inc. 109 pp.

Bowman, R.E. 1986. Effect of regurgitation on stomach content data of marine fishes. In Simenstad, C.A. and G.M. Cailliet (eds.). Contemporary studies on fish feeding: The proceedings of GUTSHOP '84, Env. Biol. Fish. 16(1-3): 171-182

Brock, R.E. 1985. Preliminary study of the feeding habits of pelagic fish around Hawaiian fish aggregation devices or can fish aggregation devices enhance local fisheries productivity? Bull. Mar. Sci. 37(1): 40-49,

Cailliet, G. M., B.S. Antrim, and D.A. Ambrose, 1979. Trophic spectrum analysis of fishes in Elkhorn Slough and nearby waters. In: S. Lipovsky and C. Simenstad (eds.). Proc. Second Pacific Northwest Technical Workshop, Fish Flood Habits Studies, Sea Grant Publ. WSG-WO-79-1 :118-128,

Cailliet, G.M. and J.P. Barry. 1979. Comparison of food array overlap measures useful in fish feeding habit analysis. In: S. Lipovsky and C. Simenstad (eds.). Proc. Second Pacific Northwest Technical Workshop, Fish Food Habits Studies, Sea Grant Publ. WSG-WO-79-1: 67-79.

Cailliet, G, M., M.S. Love, and A. W. Ebeling. 1986. Fishes: A Field and Laboratory Manual on Their Structure, Identification, and Natural History. Wadsworth Publishing Company, Belmont, California, 194 pages.

Fritz, E.S. 1974. Total diet comparison in fishes by Spearman rank correlation coefficients. Copeia 1974(l): 210-214.

Genin, A., L. Haury and P. Greenblatt. 1988, Interactions of migrating zooplankton with shallow topography: Predation by rockfishes and intensification of patchiness. Deep-Sea Res. 35(2A): 151-175.

Hyslop, E.J. 1980, Stomach content analysis, a review of methods and their application. J. Fish Biol. 17:411430

Linton, L, R., R.W. Davies, and F.J. Wrona. 1981. Resource utilization indices: An assessment. J. Animal Ecology 50:283-292.

Love, M.S. and A.W. Ebeling. 1978. Food and habitat of three switch-feeding fishes in the kelp forests off Santa Barbara, California. Fishery Bull, 76(1): 257-271,

Love, MS. and W.V. Westphal. 1981. Growth, reproduction, and food habits of olive rockfish, *Sebastes serranoides*, *off* central California. Fishery Bull. 79(3): 533-545.

Matthews, K.R. 1985. Species similarity and movement of fishes on natural and artificial reefs in Monterey Bay, California. Bull. Mar. Sci. 37(1) :252-270.

Matthews, K.R. 1986. Movement of two nearshore, territorial rockfishes previously reported as non-movers and implication to management. Calif. Fish and Game 72(2): 103-109,

Miller, D.J. and J.J. Giebel. 1973. Summary of blue rockfish and lingcod life histories; a reef ecology study; and giant kelp, Macrocystis pyrifera, experiments in Monterey Bay, California. Calif. Dept. Fish and Game, Fish Bull. (158): 1-137.

Pinkas, L., M.S. Oliphant, and I.L.K. Iverson. 1971, Food habits of albacore, bluefin tuna and bonito in California waters. Calif. Dept. Fish and Game, Fish Bull. (152): 1-105.

Solonsky, A.C. 1985. Fish colonization and the effect of fishing activities on two artificial reefs in Monterey Bay, California. Bull. Mar. Sci. 37(l): 336-347.

Vodopich, D.S. and J.J. Hoover, 1981, A computer program for integrated feeding ecology analysis. Bull. Mar. Sci. 31 (4): 922-925.

Wallace, R. K., Jr. 1981. An assessment of diet-overlap indices, Trans. Am. Fish Sot. 110: 72-76.

Quantitative Surveys of Fishes at SCUBA Diving Depths

Gary E. Davis

Channel Islands National **Park**
1901 Spinnaker **Drive**
Ventura, CA 93001

Adequate assessment of the effects of OCS oil and gas production platforms on fish and fisheries requires accurate measurements of fish abundance, Standard visual assessments of fish population density need to be more rigorously tested for accuracy, especially if they are to be combined with density estimates of benthic invertebrates and algae to describe ecological dynamics.

Population estimates of four kelp forest fishes were made using *in situ* mark-resighting techniques and modified Schnabel multiple censuses at three locations near the California Channel islands. A diver-controlled electroshocking device was used to collect fish for tagging. Resightings were made by SCUBA divers in study sites of 0.6, 1.8, and 7.1 hectares (ha) from 1 hour to 84 days after release.

Mean population densities calculated for these sites were 1,500 ha^{-1} for California sheephead (*Semicossyphus pulcher*), 1,228 ha^{-1} for kelp bass (*Paralabrax clathratus*), 2,061 ha-’ for black perch (*Embiotoca jacksoni*), and 238 ha^{-1} for garibaldi (*Hypsypops rubicundus*). These densities are two to three times greater than those previously reported for southern California kelp forests.

These mark-resighting generated densities were compared with indices of abundance produced simultaneously by three techniques that are commonly used to estimate fish population densities; visual transects, color video-taped transects, and timed counts at baited stations. Although precise, the three techniques inconsistently estimated fish abundance, with mean accuracies of 8% to 38% of the mark-resighting density estimates. Of the three techniques tested, visual transects provided **the most** accurate and precise estimates.

Visual transect counts of fishes should be used only as indices of abundance and not converted to population densities without verification.

Using Submersibles to Estimate the Abundance and Distribution of Deep Reef Fishes

M.A. Hixon[1,2], D.J. Stein[2], W.G. Pearcy[2], and B.N. Tissot[1]

[1]Department of Zoology and
[2]College of Oceanography
Oregon State University
Corvallis, OR 97331

We have been funded by the NOAA National Underwater Research Program (NURP) for the past two years and by MMS for the next three years to explore, describe, and monitor deep reef-fish assemblages off central Oregon. Our sampling design emphasizes replicate visual belt transects for conspicuous demersal fishes and benthos using submersibles. We believe that our methods are robust because we have run transects successfully over very diverse bottoms, ranging from rock pinnacles to flat mud, and have employed two very different submersibles: International Underwater Corporation's *Mermaid II* and Marfab's *Delta*. Our study area is Heceta Bank, a major commercial fishery region. The bank is located 55 km offshore on the edge of the continental shelf, and ranges in depth from less than 100 m to over 300 m. This region supports commercial fisheries for a variety of species including rockfishes, sablefish, and flatfishes.

During approximately two-hour dives, we run two 30-minute transects (each about 1 nautical mile long) stratified along depth contours. We measure both the width and the length of the transect, allowing us to calculate fish densities (number/m^2). Using tape recorders, the primary observer continuously logs data on species, abundance, size (total length), behavior, substrate, and dominant benthos without taking his eyes off the transect path. If a second observer is on board, data are also entered into electronic event recorders, facilitating later data entry into a shipboard computer. Permanent visual records of each transect are logged on videotape and still-photography mosaics. In cases where species cannot be identified visually, we collect voucher specimens with an ichthyocide dispenser and slurp gun attached to the submersible's manipulator arm. (We have found that videotapes from the ROV *Recon IV* do not provide the visual resolution necessary to identify the many similar species of rockfishes at our site.)

To accurately estimate fish lengths, as well to provide a scale for our photography, we suspend by a chain into the transect path a fiberglass rod marked in decimeter intervals. Such external scales are especially important for submersibles with domed **ports,** which greatly distort outside images,

We evaluated the potential of sampling error due to the submersible attracting or repelling fish in **two** ways. First, we observed that fish in the periphery of our visual field did not move toward the sub as we approached, nor did they swim away from the sub until we were very close, The sole exception was that some schools of yellowtail rockfish (*Sebastes favidus*) followed the sub for short periods. Second, between transects on every dive, we turned-off the submersible's floodlights, internal lights, and motors for ten minutes. When we again turned-on the lights, we noted that nearby fish had not changed in abundance and distribution, suggesting that the presence of the submersible *per se* caused little sampling bias.

To date, we have analyzed our data from 1987, the first year of our study (Pearcy *et al.* submitted to Fishery Bulletin). We subdivided twenty transects run during ten dives **into 21** transect segments, each of uniform depth and dominant substrate. Multivariate analyses (PCA and group-average cluster analysis) based on both abundance and presence-absence distinguished four habitat groupings of fishes:

(1) Shallow (65-1 50 m) rock pinnacles and ledges: This region was dominated by rockfishes, including large aggregations of yellowtail, sharp-

chin (S. *zacentrus*), and Pygmy rockfish (S. *wilsoni*). We also encountered large aggregations of juvenile rockfishes in this and the next region, indicating that Heceta Bank may constitute a nursery area for some species. The dominant macrobenthos included crinoids, sponges, and basket stars.

(2) Shallow (122-145 m) boulders and cobble: This and the following region comprised transition zones between shallow rock and deep mud. Rockfishes also dominated this zone, especially reset horn rockfish (S. *helvomaculatus*), which was abundant in all rocky areas regardless of depth.

(3) Deep 140-220 m) cobble and gravel: This region was similar to the previous zone, except for a greater representation of flatfishes, characteristic of the next region.

(4) Deep (165-300 m) sand and mud: This zone was dominated by sablefish (*Anoplopoma fimbria*) and various flatfishes, including slender (*Lyopsetta exilis*), clover (*Microstomus pacificus*), and rex sole (*Glyptocephalus zachirus*). Dominant macroinvertebrates included various urchins, stars, and cucumbers,

Our future analyses will include replicate transects to allow relative assessment of within versus between-year variation in these assemblages. We are also testing ultrasonic tags to track large rockfishes, thus providing data on diel movements and home ranges. Ultimately, our study will provide baseline information for future management decisions concerning this important fishery region.

An Overview of the Potential Uses of Fixed Location and Mobile Hydroacoustic Methods for the Study of Fish Populations In and Near Oil and Gas Production Platforms

Tom Carlson

Biosonics
4520 Union Bay Place, N.E.
Seattle, WA 98105

Introduction

Almost everyone is familiar with the "fish finders" commonly used by sports and commercial fishermen to detect the presence of fish. In addition, everyone knows that the Navy uses sonar extensively for national defense purposes. Almost no one knows that extrapolations of these instruments are very useful to provide quantitative information to assist in the management of natural resources, especially fish populations.

Structures such as oil platforms have proven to be excellent fish aggregation devices and, once in place, quickly develop an ecology all of their own, Of considerable interest is the abundance, distribution and behavior of fish within the supporting structures of these platforms and the relationship of this population with other elements of the fish community in the general region of the platform. Hydroacoustics, the quantitative application of sonar technology, has many advantages to offer in the study of fish communities both within the platform structure in addition to the general region of the platform.

Hydroacoustic systems are deployed using two general methods: mobile and fixed location.

Mobile Survey Methods

Using mobile methods, the hydroacoustic system, which consists of a scientific quality echo sounder, transducer, cable, data display, processing and recording instruments, is located aboard a boat, The boat is driven in a predetermined transect pattern designed to permit the hydroacoustic system operator to sample a predetermined portion of the water volume within a region of interest, Although hydroacoustic systems consist of the same basic elements, the configuration of the elements and their design and function are commonly optimized for specific sampling tasks. For example, a typical mobile hydroacoustic system is a set of instruments located aboard a large oceangoing research vessel optimized for assessment of commercial fish resources; another mobile hydroacoustic system, comprised of the same basic elements but with different operational characteristics, is a system mounted on a remotely operated vehicle designed for the quantitative assessment of plankton populations.

Hydroacoustic data can be processed as it is acquired or recorded for latter processing, In either case, if properly acquired, the echo returns from fish detected during such surveys can be processed to provide: 1) estimates of the biomass or numbers of fish within the surveyed region; 2) detailed 'maps' of the horizontal and vertical distribution of detected fish, 3) estimates of the size distribution of detected fish and 4) detailed observations of the macro and micro behavior of fish,

In the case of oil platforms, elements of the relationship between the fish within platform structures and those in the general area of the platform can be revealed or made clearer by data acquired during mobile hydroacoustic surveys, Hydroacoustic surveys have the advantage of being relatively easy to conduct, provide rapid and comprehensive coverage of large regions, and return a great deal of data per dollar spent. Recent advances in scientific hydroacoustic instrumentation, particularly the development of signal processing hardware and software for personal computers, have made the equipment considerably easier to operate and greatly eased the task of processing and analysis of rather prodigious amounts of data acquired during a typical hydroacoustic survey.

Hydroacoustic surveys are most profitably conducted as elements of more comprehensive investigative efforts. Other sampling methods provide information useful in interpretation of hydroacoustic data and, on the other hand, hydroacoustic data can provide considerable enhancement to other sampling and data interpretation tasks. For instance, almost all other biological sampling methods use point sampling tools, such as water bottles, grabs, nets of various sorts, etc. In almost all cases the volume or area sampled is a very small, often infinitesimal, portion of the total region of interest. Hydroacoustic sampling can provide valuable data to assist in choosing sampling locations to optimize study objectives in addition to contextual information to assist interpretation of samples in the context of the whole process under study.

Fixed Location Methods

Fixed location hydroacoustic systems differ from mobile systems in two important ways: 1) the hydroacoustic system is maintained in one position rather than moving along a survey path and 2) typically more than one sensing element or transducer is connected to the central elements of the hydroacoustic system.

In fixed location sampling, the hydroacoustic system transducers are aimed into regions where events of interest are occurring or are expected to occur. Such events might be the movement of fish up a river, the passage of fish into the turbines of a hydropower dam, the behavior of fish in the vicinity of power plant intake, the dispersion of fish from a reef at sunset and their return upon sunrise, and finally the behavior of fish in the immediate vicinity of an oil platform in response to man made or natural stimuli.

Fixed location sampling is particularly useful for obtaining detailed, continuous coverage of a region of interest. The size of the region covered is dependent upon the number of transducers deployed, characteristics of the other system elements and system parameters selected during sampling, The same types of quantitative information available using mobile methods are also available using fixed location methods. Examples include but are not limited to: the number and size of fish passing through the ensonified volumes, the flux of fish per unit time, direction of travel and swimming velocity and location in the water column.

Conclusions

Oil and gas platforms appear to offer few challenges that cannot be overcome by adapting commonly utilized hydroacoustic instruments and data acquisition and analysis methods.

Oil platforms offer particularly interesting locations for hydroacoustic sampling. The structures themselves provide ample locations for mounting the transducers of fixed location hydroacoustic systems to “look” either within the structures on in the immediate vicinity outside the structures. The availability of power and communications provide all the necessary elements for implementation of currently available autonomous hydroacoustic systems which could be operated by personal computer over phone lines from offices ashore. Acquired data could be transmitted to personal computers ashore for analysis providing the potential for extensive coverage on a very cost effective basis.

The platforms provide points of reference for design and implementation of mobile hydroacoustic studies to assess the abundance, distribution and aspects of the behavior of fish within the general region of the platforms.

An Overview of Submersible Technology and Methods

Bruce H. Robison

Monterey Bay Aquarium
Research Institute
160 Central Avenue
Pacific Grove, CA 93950

There are four basic characteristics which determine vehicle type: tethered and untethered, which influences power and mobility; manned and unmanned, which affects control systems. The four basic combinations are: tethered, unmanned Remotely Operated Vehicles (ROV); tethered, manned Atmospheric Diving Systems (ADS); untethered, unmanned Autonomous Underwater Vehicles (AUV); and untethered, manned submersibles (Subs). While much of this equipment was designed for use by offshore industry, it took a long time to integrate them into offshore research programs.

Each of the basic system types has both strengths and inherent weaknesses: Tethered systems offer greater endurance than untethered, while untethered vehicles have much greater mobility; unmanned systems are generally are generally lighter and smaller than manned vehicles, while manned systems offer superior visibility and manipulative capabilities.

Illustrated examples of representative vehicles used for research: *ALVIN, JOHNSON-SEA-LINK, DIAPHUS, WASP, MANTIS, DEEP ROVER, PHANTOM, MINI-ROVER, and HYSUB AT40*. Regardless of vehicle type, there is a broad range of tools and instrumentation available for research. Tools include manipulators, and samplers. Of the later, there are suction samplers, traps, water catchers, nets, pumps, etc.

Instrumentation includes standard CTD units as well as transmissometers, oxygen sensors, current or flowmeters and altimeters. For chemical sensing, nearly any compound that can be characterized spectrophotometrically can be quantitatively assessed *in situ* with flow injection technology.
Among available acoustic systems are echo sounders for bottom finding, scanning sonars for obstacle and target assays, doppler acoustics for flow rates and zooplankton abundance, dual beam sonars for quantitative size assessments of zooplankton, and multiple frequency assays for zooplankton biomass and dynamics. There are also hydrophore arrays for passive acoustics and monitoring natural sound patterns.

Despite all the capabilities of acoustic systems there is still one critical element lacking in all acoustic data - without visual systems to complement the acoustics we cannot identify the targets. Species specific acoustic signatures are lacking. However, one of the most powerful trends in the development of enabling technologies for *in situ* research is the coupling of optical and acoustic technologies.

Imaging systems have advanced very rapidly in recent years to include a variety of video capabilities: low-light cameras, high resolution color, range-gated cameras, spectral analysis systems, miniaturized cameras, hybrid video and still cameras, and three-dimensional systems. To the video signals we can apply frame-grabbing and digital image analyses as well as computer-based motion analyses.

Optical imaging also encompasses a range of still photography formats in single frames or stereo. Electronic images can be generated remotely, digitized, and sent to the surface as coded acoustic pulses without a direct link to the subsurface vehicle. Optical imaging requires light and there are a number of new kinds available, such as metal halide lamps for far-field illumination, lasers for spot illumination, and paired lasers for measurements of range and spatial separation.

Instrumentation also includes navigation, both as the surface and subsurface. Modern navigation systems integrate location data from a variety of real-time sources and can function interactively to add to a data base of references. Subsurface transponder grids allow the reliable relocation of vehicles to experimental sites or survey locations,

One of the principal problems facing those who use these new subsurface sensor systems is the same one encountered with satellite data systems - how to handle the enormous data output potential. Communication systems have been greatly aided by fiber optics technology and by the ability to digitize imagery from a variety of sources for computerized analyses. Microwave telemetry permits real-time control and data transmissions that significantly improve our ability to operate submersible systems effectively. Software for filing, cataloging and retrieving data has also improved. Most recent has been the development of interactive data base systems that allow integrated, additive exchanges with the data base, in either real time or lagged time.

Advances in research technology go hand in hand with developments in methodology. While *in situ* research methods are generally superior to conventional techniques for working at 100-200 m, they too have inherent biases that we must assess and account for in our interpretation of data.

Overall, submersible technology offers the most effective means for meeting MMS's needs for deep reef research. However, real care must be taken to insure the proper selection of vehicle characteristics for the job at hand. And the scientific rigor of the research must match the advanced capabilities of the technology.

Sublethal Effects of Contaminants on Fishes

Robert B. Spies

University of California
Lawrence Livermore National Laboratory
Livermore, California 94550

A review of sublethal effects of contaminants on fishes was presented and several measures were recommended for monitoring near offshore oil drilling platforms. Contaminants can be accumulated by fishes through food, from water and from direct contact with sediment, A number of studies have shown that most metals, except mercury, have very similar concentrations in fishes from areas of elevated anthropogenic inputs and from less contaminated areas. Therefore, most anthropogenic metals may not pose a threat to fishes, and our efforts should be focused on organic contaminants which have been more directly related to toxic effects in fish populations.

Contaminants within fish, constituting a dose measurable by conventional chemical analyses (e.g., gas chromatography), can directly cause tissue irritation and inflammation, Accumulation of unaltered organic contaminants (e.g., low-molecular-weight aromatic hydrocarbons) in nerve tissue can also lead to narcosis.

Most organic contaminants (with the notable exception of highly substituted chlorinated aromatic hydrocarbons), however, are metabolized by the P-450 enzyme system and so their concentration are usually low. Specific methods have developed for analysis of contaminant metabolizes in bile or urine, where they can occur in high concentration.

Since specific isozymes in the P-450 enzyme system are induced to high levels of activity in fish by exposure to a broad range of potentially toxic organic contaminants, measurement of P-450 or specific isoenzymes, either directly or through their activities, provides a sensitive contamination-specific measure of exposure. Measurements of contaminant-metabolizing activity of fishes in nearshore waters of California and in other areas of the world have shown that P-450 enzyme induction is a sensitive and biologically meaningful response to contamination.

In addition, there are potential population-level effects of **P-450 induction, as** female starry flounder from San Francisco Bay with elevated P-450 activities at the time of spawning have reduced reproductive success. The initial **product of P-450 metabolism (phase I metabolism)** is in many cases, an epoxide which is either eliminated from the body through conjugation to a second molecule, e.g., a **glucoronide,** (Phase II metabolism); it may also bind **covalently to** proteins or DNA. Such chemical lesions on DNA (DNA **adducts)** can now be detected in fish by the 32P-post-labeling technique, Some preliminary evidence indicates that DNA damage is not repaired in fish as quickly as it is in mammals. If the DNA damage is not repaired before cell division, is inappropriately repaired, or if the **adducts** are at **critical** portion of the DNA molecule, the genetic damage may be propagated as a mutation, **chromosomal** aberration, or as subsequent translational errors during gene expression and regulation. Such genetic errors in the hemopoietic tissues of fish underlie the observed elevated incidence of micronuclei in circulating **erythrocytes** (red blood cells) of fish in contaminated nearshore environments of California.

A **third area** of response is immune suppression. The initial defense of fishes to foreign objects, such as pathogenic bacteria, is uptake by **phagocytic macrophages.** The activities of macrophages are impaired in several ways by exposure to high concentrations of **polynuclear** aromatic hydrocarbons in estuarine environments. Such immune suppression may underlie the increased incidence of pathogenic disease observed in some populations of fishes in contaminated environments.

In summary, several of the most promising indicators of sublethal effects of contaminants on fishes include: (1) induction of p-450 enzymes, (2) reproductive impairment, (3) micronucleus occurrence, (4) DNA adduct detection, and (5) microphage function.

Study Potentials and Priorities

Alfred W. Ebeling

Department of Biological Sciences
University of **California**
Santa Barbara, CA 93106

As I understood it, there was unanimous agreement that observations of deep-living fishes on and about Platform Hidalgo must be made using either manned submersibles or ROV's, as alternative methods such as trawling or hook-and-line fishing are either impractical or woefully biased, Some advantages and disadvantages of manned and remote vehicles were pointed out but whether one or the other -or even a combination of the two is most appropriate - awaits further consideration. Maximum use should be made of new technologies for observation, for example back-lighting to reduce intermediate scatter, low-light level photography, and systems for coupling acoustic and optic imaging.

CAMP phases I and II provide an excellent basis of environmental knowledge on which to launch the fish study. The previous work has revealed various sources of natural variability - seasonal, yearly, etc., in the benthic assemblage. Therefore, a major consideration in designing the fish sampling study will be to assess natural variability over a long time so that any environmental signals from oil development can be properly discriminated. Such information will be important when (and if) Platform Julius is commissioned.

Recent studies have indicated that counts of fish from video images may tend to underestimate abundances of schooling and cryptic species. Therefore, careful surveys using high-resolution equipment should be made, and additional destructive collections may be used to complement the surveys by camera.

There was general agreement that the study should highlight three major topics: Temporal Variation and Redistribution of Fishes in the Platform Region, Feeding of Fishes Relative to Prey Availability, and Assessment of Sublethal Effects on Fish Populations, Most of the effort will focus on two guilds: midwater and bottom species, mostly of rockfishes. In addition, it was suggested that a reconnaissance of cryptic fishes would be valuable, perhaps made by targeting cracks and crevices with squirts of rotenone or other poisons.

1. Temporal Variation and Redistribution: The question of whether an oil platform like Hidalgo merely attracts fish from nearby natural reefs or generates its own food chain, thereby increasing overall fish production in the region is difficult to answer even with an intensive sampling program, With population levels fluctuating from season to season and from one year to the next, it may be nearly impossible to estimate the carrying capacity of the regional environment for rockfish and other species. Thus, any signal of increased carrying capacity due expressly to the platform is lost in the ambient noise. Besides monitoring densities at and about the platform, individuals should be hooked and tagged. Returns from commercial fishing in the area should provide some indication of movements of sedentary and mobile species between natural reefs and the platform.

A. Tagging, perhaps using easy release (breakaway) hook tags to release the fish, which suffer embolisms if brought to the surface, from depth.

B. **Compare movements** of mobile versus sedentary species as members of the mobile guild may show greater temporal variability and redistribution about the platform.

C. Compare fish densities among the following habitats, after an initial mapping to see if replicate sites are available for each: platform, high relief natural reef, low-relief natural reef, within and outside of tailings plume. Thus, the study could be designed as a factorial ANOVA.

D. Assess population structure in the different habitats by classifying individuals, whenever possible, as juvenile, sub-adult and adult. Perhaps a SCUBA survey could be made in shallower water about the platform to see if rockfishes recruit directly from the platform to the structural members.

E. Monitor commercial and sport fishing activity in the region,

II. Feeding study. Gut content analysis of the more abundant species, together with estimates of prey availability, should be made to see if feeding is enhanced by the benthic and plankton communities of prey supported by the platform, relative to the forage base provided by the nearby natural rocky reefs. Matrices of predators, prey, and food availabilities for platform and reef environments may provide needed insights as to the regional importance of food chains associated with natural and artificial structures.

III. Study of the sublethal effects of pollutants generated by the drilling activities. For example, recent techniques of relating changes in detoxifying enzyme activity to pollutant levels may provide ultra-sensitive indicators of tissue contamination.

Workshop Agenda

Public Workshop
December 14, 1988

Sponsor: U.S. Department of the Interior
Minerals Management Service
Pacific OCS Region

Host: Occidental college
Los Angeles, **California**

Effects of an OCS Oil and Gas Production Platform
on Rocky Reef Fishes and Fisheries

Purpose:

To provide a forum to discuss state of the art sampling methods and analytical techniques for evaluating any changes in the abundance, distribution, and physiology of fishes, living adjacent to a site of offshore oil and gas development and production; and furthermore, to receive recommendations and comments on priorities for experimental designs that may be applied to studies planning and subsequent research.

Agenda:

8:00 Registration
Coffee

8:30 Welcome *and Introduction*
John Stephens, Occidental College
Gary Brewer, Minerals Management Service

9:00 *Overview of the California OCS Phase II #monitoring Program (CAMP}*
Jeff Hyland, Battelle Ocean Sciences, Ventura

9:30 *Hard-Bottom Assemblages Near Platform Hidalgo*
Dane Hardin, Kinnetic Laboratories, Santa Cruz

10:00 *Quantitative Assessment of Deep Water Benthic Fish Populations: Survey Methods and Analytical Techniques*
Andy Lissner, Science Applications International Corporation, San Diego; Susan Benech, Benech Biological Associates, Ventura; Doug Diener, MEC Analytical Systems, Encinitas

10:30 Coffee

10:45 *Fisheries off Pt. Conception: Potential Techniques in Platform Effects Studies*
Milton Love, University of California, Santa Barbara

11:15 *Feeding Habits of Fishes Associated with Offshore Oil Platforms and Adjacent Deep Water Reefs: What Can We Learn?*
Greg Cailliet, Moss Landing Marine Lab, Moss Landing

11:45 *Quant i tat ive Surveys of Fishes at SCUBA Diving Depths*
Gary Davis, National Park Service, Ventura

12:15 Lunch

1:15 *Using Submersibles to Estimate the Abundance and Distribution of Deep Reef Fishes*
Mark Hixon, Oregon State University, Corvallis

1:45 *An Overview of the Potential Uses of Fixed location and Mobile Hydroacoustic Methods for the Study of Fish Populations In and Near Oil and Gas Production Platforms*
Tom Carlson, Biosonics, Seattle

2:15 *Sublethal Effects of Contaminants on Fishes*
Bob Spies, Lawrence-Livermore Laboratories, Livermore

2:45 *An Overview of Submersible Technology and Methods*
Bruce Robison, Monterey Bay Research Institute, Pacific Grove

3:15 Coffee

3:30 *Study Potentials and Priorities: A Round Table Discussion*
Al Ebeling, University of California, Santa Barbara

5:00 Concluding Remarks and Adjourn
Wine and cheese reception-following immediately, hosted by Occidental College.

Please register at the front desk. All registrants will be mailed a *Workshop Proceedings Report* approximately January 15, 1989.

A Request for Proposals (RFP) on "Effects of an OCS Oil and Gas Production Platform on Rocky Reef Fishes and Fisheries" will be released in February 1989. Sign-up at registration desk to receive a copy of the RFP.

Information about the Minerals Management Service, Environmental Studies Program, including past and current studies, studies reports and publications is available at the front desk.

Workshop Registrants

Bob Middleton
Minerals Management Service
12203 Sunrise Valley Drive
Reston, VA 22070

Michael Brody
Minerals Management Service
Atlantic OCS Region
1951 Kidwell Drive, Suite 601
Vienna, VA 22180

Gary E. Davis
National Park Service
Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001

Jack Engle
The Tatman Foundation
Catalina Marine Science Center
P.O. 60x 3 9 8
Avalon, CA 90704

Donna Brewer
U.S. Fish & Wildlife Service
24000 Avila Road
Laguna Niguel, CA 92656

Greg Cailliet
Moss Landing Marine Labs
P.O. Box 450
Moss Landing, CA 95039

Fred Piltz
Minerals Management Service
Pacific OCS Region
1340 W. 6th Street
Los Angeles, CA 90017

Jeff Cross
SCCWRP
646 W. Pacific Coast Highway
Long Beach, CA

Richard Nitsos
Calif. Dept. of Fish & Game
330 Golden Shore, Suite 50
Long Beach, CA 90802

John Steinbeck
TENERA Environmental
P.O. Box 400
Avila Beach, CA 93422
(805) 544-9011

Helmut Gieren
Calif. Coastal Commission
631 Howard Street, 4th Floor
San Francisco, CA 94105
(41 5) 543-8555

Dee W. Chamberlain
Atlantic Richfield Co.
515 S. Flower Street
Los Angeles, CA 90071

Eddy Konno
Minerals Management Service
Pacific OCS Region
1340 W. 6th Street
Los Angeles, CA 90017
(213) 894-7096

Joann Golden
Minerals Management Service
Pacific OCS Region
1340 W. 6th Street
Los Angeles, CA 90017
(213) 894-3379

Phil Schenck
Central Coast H&C
14212 Alta
West Minister, CA 92683
(714) 898-7825

Donald Wilson
CBR International
641 6-103rd N.E.
Kirkland, WA 98033
(206) 822-7380

Many Meisler
Minerals Management Service
Pacific OCS Region
1340 W. 6th Street
Los Angeles, CA 90017
(213) 894-4472

Bob Spies
University of California
UCLLNL
Box 5507
Livermore, CA 94550

Bob Kanter
MEC Analytical Systems
2433 Impala Drive
Carlsbad, CA 92009

Peter Adams
National Marine Fisheries Service
3150 Paradise Drive
Tiburon, CA 94920

Jan Cordes
CSWN
28186 Frelane Drive
cc co. 91351

Tom Carlson
BioSonics
6036 Princeton Ave., N.E.
Seattle, WA 98105
(206) 527-0905

Dennis Lees
WESTEC Services
5510 Morehouse Drive
San Diego, CA 92121

Jerry Frost
Unocal
P.O.Box 6176
Ventura, CA 93006

Brian J. Balcom
Continental Shelf Associates
1695 Mesa Verde Ave., Suite 200
Ventura, CA 93003

Jay Carroll
TENERA Environmental
P.O. Box 400
Avila Beach, CA
(805) 544-9011

Bruce Robison
MBARI
160 Central
Pacific Grove, CA 93950

Anne Holmquist
Chevron Oil Field Research
P.O.Box 446
La Habra, CA *90633-0446*

Roslyn Muller
Chevron USA Inc.
P.O.Box 6917
Ventura, CA 93003

Ann Scarborough Bull
Minerals Management Service
Gulf of Mexico Region
1201 Elmwood Park Blvd.
New Orleans, IA 70123

Martin Golden
Minerals Management Service
Pacific OCS Region
1340 W. 6th Street
Los Angeles, CA 90017
(21 3) 894-7105

Don Barthelmess
IUC Pacific
4835-B Colt **Street**
Ventura, CA 93003

Dale Graves
IUC Pacific
4835 Colt
Ventura, CA 93003

Milton Love
Marine Science Institute
UC Santa Barbara
Santa Barbara, CA 93106

Al Ebeling
Biological Science
UC Santa Barbara
Santa Barbara, CA 93106

Larry Allen
OSI
CSU Northridge
Northridge, CA 91330

Michael Franklin
OSI
CSU Northridge
Northridge, CA 91330

Mark Hixon
Oregon State University
Zoology and Oceanography
Corvallis, OR 97331
(503) 754-3705

Pamela Morris
Chambers Group Inc.
2933-B Pullman Street
Santa Ana, CA 92705
(714) 261-5414

Jay Shrake
Kinnetic Labs Inc.
3050 Paul Sweet Road
Santa Cruz, CA 95061
(61 9) 438-8968

Andrew Lissner
SAIC
4224 Campus Point Drive
Mail Stop 10
San Diego, CA 92121

Terry Parr
Kinnetic Labs
5225 Avenida Encinas
Carlsbad, CA 92008

Jake Patton
WESTEC
5504 8th Street
Fallbrook, CA 92028
(61 9) 723-0323

Eugene Bromley
EPA, Regional
215 Fremont Street
San Francisco, CA 94105
(41 5) 974-8330

Eiji Imamura
Battelle
1431 Spinnaker Drive
Ventura, CA 93001

Gary Brewer
Minerals Management Service
Pacific OCS Region
1340 W. 6th Street
Los Angeles, CA 190017
(213) 894-4023

Chuck Mitchell
MBC
947 Newhall Street
Costa Mesa, CA 92627

W. L. Stakta
MBC
947 Newhall Street
Costa Mesa, CA 92627

Mary Bergen
State Lands Commission
1807 13th Street
Sacramento, CA 95814

Jim Allen
MBC
947 Newhall Street
Costa Mesa, CA 92629

Jim Slawson
NOAA
300 S. Ferry Street
Terminal Island, CA 90731

Ed DeMartini
531 Encinitas Blvd. #105
Encinitas, CA 92024

Don Keene
ARCO
P.O. Box 147
Bakersfield, CA 93302

Susan Livenick
State Lands Commission
245 W. Broadway
Long Beach, CA 90802

John Lane
Minerals Management Service
Pacific OCS Region
1340 W. 6th Street
Los Angeles, CA 90017
(21 3) 894-4350

Sue Benech
BBA
487 Lincoln
Ventura, CA 93001

Ken Jenkins
CBR International
4404 Pacific Coast Highway
Long Beach, CA 90805
(21 3) 597-5007

Andrew Gillam
CBR International
4404 Pacific Coast Highway
Long Beach, CA 90805
(213) 597-5007

Andrew Brooks
Moore Lab
Occidental College
1600 Campus Road
Los Angeles, CA 90041

Bill Westphal
Moore Lab
Occidental College
1600 Campus Road
Los Angeles, CA 90041

Murray Dailey
Ocean Science Institute
CSULB
Long Beach, CA 90840

Jeff Hyland
Marine Science Institute
UCSB
Santa Barbara, CA 93106

Rich Slater
DELTA
4500 Falkirk Bay
Oxnard, Ca 90305

John Stephens
Biology Department
Occidental College
1600 Campus Road
Los Angeles, CA 90041

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.