

Aerial Surveys of Seabirds and Marine Mammals in the Gulf of the
Farallones Region, 12 December 1984

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This report summarizes the results and findings of the sixth of a series of aerial surveys conducted over the Gulf of the Farallones region in response to oil pollution resulting from the explosion and partial sinking of the T/V *Puerto Rican*. Marine mammal and seabird sightings within a 50 meter survey corridor were recorded along predetermined east-west transect lines (Fig. 1) flown at 65m altitude at 165-185 km per hour. The data obtained are converted to bird or mammal densities as number of animals per square kilometer ($\#/km^2$) within specified areas, usually depth zones (inner shelf, <100m; outer shelf, 100-200m; and slope, 200-3000m).

Survey conditions were relatively poor during this flight, with strong northwest winds prevailing everywhere within the study area except inside Monterey Bay. Winds of 30 to 50 knots whipped the ocean surface into nearly-continuous white-water conditions, making detection of small, inconspicuous birds (e.g. auklets, storm-petrels) difficult. Marine mammal sightings were probably also somewhat diminished.

SEABIRDS

We recorded twenty-four seabird species during this flight (Table 1). Overall seabird abundance and distribution were similar to those found in our first five surveys in the region. Highest densities occurred over shelf waters between Pt. Reyes and Half Moon Bay; lowest numbers occurred over slope waters and north of Pt. Reyes. We found peak densities in Drake's Bay ($340 \text{ birds}/km^2$), near Southeast Farallon Island ($180 \text{ birds}/km^2$), and over shelf waters south and east of the Farallones ($60-85 \text{ birds}/km^2$).

Gulls, alcids and shearwaters remained as the principal components of the seabird fauna, accounting for 97% of all birds seen. Gulls alone comprised 59.1% of the total, and alcids (mainly Common Murres) comprised 31.4%. Over slope waters, however, gulls and alcids were outnumbered by procellariiform species (mainly Northern Fulmars).

Southbound migrants, especially Arctic Loons and Bonaparte's Gulls which occurred in significant numbers during our November surveys, declined in importance during this sixth flight.

Loons and Grebes

Small numbers of Arctic Loons and Western Grebes were the only members of this grouping recorded during this survey. Most of the loons and all the grebes were sighted on inner shelf waters, mostly from Pt. Reyes south. A single Arctic loon was seen 20km west of Southeast Farallon Island.

Procellariiformes

Although we recorded six tubenose species on this survey, Northern Fulmars accounted for the great majority of those sighted. Fulmars occurred in all depth zones, but were most numerous over waters of the outer shelf and slope, where densities averaged 5.4 birds per km² and 2.2 birds per km², respectively. Peak fulmar densities (14.5 birds/km²) were recorded on outer shelf waters west of Half Moon Bay. Other procellariiform species seen included a single Laysan Albatross southwest of Southeast Farallon Island, and small numbers of Sooty, Short-tailed, and Black-vented Shearwaters, mostly in the vicinity of the Farallones. One unidentified and one Ashy Storm-Petrel were recorded west and southwest of Southeast Farallon Island, respectively.

Pelecaniforms

The only pelecaniform sighted was a single Brandt's Cormorant near Southeast Farallon Island.

Waterfowl

Four unidentified, and one Surf Scoter, all seen near Martin's Beach (San Mateo County) were the only waterfowl sighted.

Phalaropes

Phalarope (probably Red Phalarope) sightings declined from November levels, as their migration wave continued to recede. Poor observation conditions during this survey probably also contributed to the low numbers observed. Highest phalarope densities (4.7/km²) occurred over outer slope waters south of Southeast Farallon Island, near the sunken stern section of the *Puerto Rican*. Most sightings were from outer shelf and slope waters; none were seen north of Pt. Reyes.

Jaegers, Gulls, and Terns

A single Pomarine Jaeger seen on outer shelf waters off Martin's Beach was the only jaeger sighting during this survey.

We recorded eight species of gulls during this flight, of which California, Western, and Herring Gulls predominated. Over 98% of all gulls were sighted over shelf waters; 96.5% occurred south of Pt. Reyes.

California Gulls comprised nearly 60% of all gulls identified to species, averaging 25 birds per km^2 over shelf waters (with unidentified gulls factored in); none were identified over the slope. Densities of this species reached 110 birds per km^2 near Southeast Farallon Island, and exceeded 60 birds per km^2 in Drake's Bay.

Western Gulls ($x_{\text{shelf}} = 6.3/\text{km}^2$) and Herring Gulls ($x_{\text{shelf}} = 3.8/\text{km}^2$) comprised the bulk of the remaining gulls identified. Black-legged Kittiwakes were the most numerous gull of the slope ($x = 0.8/\text{km}^2$), where Herring Gulls were the only other gull species seen.

Small numbers of Glaucous-winged, Mew, Bonaparte's, and Heermann's Gulls occurred at scattered shelf locations.

Alcids

We identified three alcid species during this survey; Common Murres accounted for 96% of the total seen. Except for birds recorded near the Farallones (where density = 5.6 birds/ km^2), all murre sightings occurred over waters of the inner shelf. Densities averaged 65 birds per km^2 in shallow water south of Pt. Reyes, but dropped to 1.0 per km^2 north of there. Extremely large numbers of murres occupied Drake's Bay, where densities reached over 200 birds per km^2 .

Few auklets were seen, perhaps due to the very windy conditions which made sightings of these relatively inconspicuous birds difficult. Cassin's Auklets were seen on outer shelf or slope waters on all but one transect line; maximum densities were 1.4 birds per km^2 near and south of the Farallones.

A few Rhinoceros Auklets were also recorded on transect lines south of the Farallones, and a single Tufted Puffin was logged 20 km west of Southeast Farallon Island.

MARINE MAMMALS

We encountered only two species of marine mammals on this survey flight. Approximately three hundred California sea lions were rafted next to and hauled out upon the large weather data buoy located 21 km off Martin's Beach ($37^{\circ}22'N$ x $122^{\circ}39'W$). These animals were photographed. Six Dall's porpoise were seen headed south near Cordell Bank ($37^{\circ}59'N$ x $123^{\circ}14'W$).

OIL SLICKS

No oil slicks were observed during this flight. The extremely windy conditions probably precluded sighting of small or even medium sized patches unless they were directly overflown, and were of sufficiently high viscosity to generate a "mousse" effect.

Table 1. Summary list of marine bird species sighted during Gulf of the Farallones Aerial Survey, 12 December 1984.

	<u>Inner Shelf</u>	<u>Outer Shelf</u>	<u>Slope</u>
Arctic Loon (<u>Gavia arctica</u>)	X		X
Western Grebe (<u>Aechmophorus occidentalis</u>)	X		
Laysan Albatross (<u>Diomedea immutabilis</u>)			X
Northern Fulmar (<u>Fulmarus glacialis</u>)	X	X	X
Sooty Shearwater (<u>Puffinus griseus</u>)			?
Short-tailed Shearwater (<u>Puffinus tenuirostris</u>)		X	X
Black-vented Shearwater (<u>Puffinus opisthomelas</u>)			X
Ashy Storm-Petrel (<u>Oceanodroma homochroa</u>)			X
Brandt's Cormorant (<u>Phalacrocorax penicillatus</u>)	X	X	
Surf Scoter (<u>Melanitta perspicillata</u>)	X		
Red Phalarope (<u>Phalaropus fulicarius</u>)	X	X	X
Pomarine Jaeger (<u>Stercorarius pomarinus</u>)		X	
Glaucous-winged Gull (<u>Larus glaucescens</u>)	X	X	
Western Gull (<u>Larus occidentalis</u>)	X	X	
Herring Gull (<u>Larus argentatus</u>)	X	X	X
California Gull (<u>Larus californicus</u>)	X	X	
Mew Gull (<u>Larus canus</u>)		X	
Heermann's Gull (<u>Larus heermanni</u>)	X		
Black-legged Kittiwake (<u>Rissa tridactyla</u>)		X	X
Bonaparte's Gull (<u>Larus philadelphia</u>)	X		
Common Murre (<u>Uria aalge</u>)	X	X	
Tufted Puffin (<u>Fratercula cirrhata</u>)			X
Rhinoceros Auklet (<u>Cerorhinca monocerata</u>)	X	X	
Cassin's Auklet (<u>Ptychoramphus aleuticus</u>)		X	X

Key: X = relatively numerous, x = relatively uncommon

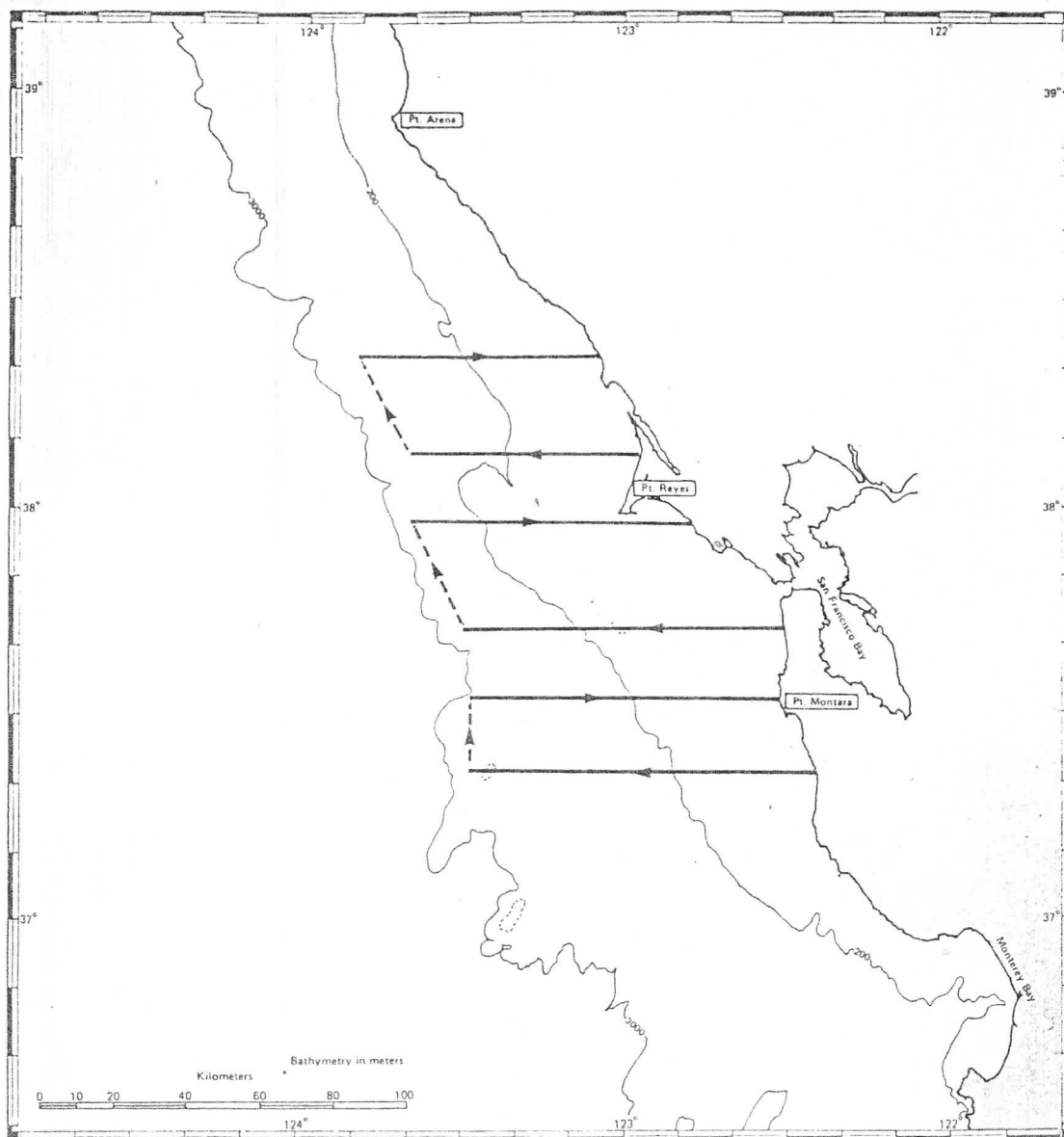


Figure 1. Aerial survey coverage of seabirds and marine mammals of the Gulf of the Farallones Region, 12 December 1984.

AN ANALYSIS OF THE IMMEDIATE EFFECT OF THE PUERTO RICAN OIL SPILL
ON THE INTERTIDAL MARINE LIFE OF MARIN COUNTY, CALIFORNIA

February 11, 1985

(Draft Copy)

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ABSTRACT

On November 3, 1984, oil slicks from the sunken stern of the tanker PUERTO RICAN flowed north to the Point Reyes Peninsula shores. An immediate survey of pre-oil and post-oil transects revealed no apparent damage to the marine intertidal invertebrates among transect sites in four regions of the peninsula coast. With oil still oozing from the sunken stern, the long-term evaluation of these intertidal populations appears to be a necessity.

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Finally, on November 18, the remaining 360-foot bow section of the PUERTO RICAN was safely towed into San Francisco Bay with its estimated remaining cargo of about 2.8 million gallons of oil. Throughout the weeks of December 1984 and into January of 1985, the Coast Guard reported that oil slicks continued to ooze from the sunken stern of the oil tanker.

The above information was compiled from press releases provided by the United States Coast Guard; the ship's owner, Keystone Shipping of Philadelphia; Clean Bay Corporation; and various other public agencies.

Of question in this report is the immediate effect of these lubricating and detergent oils on the marine organisms within the intertidal zones. The composition of these oils ranged from C8 to C14, and some of the oils contained various degrees of calcium and sulfur additives. Nearly all of the oils were classified as insoluble in water.

II. METHODS OF STUDY

The principal method of study in this report is the comparison of pre-oil spill data with post-oil spill data. Implementation of the comparisons is made through use of statistical analysis, similar to that incorporated in my studies, *Effects of the San Francisco Oil Spill of 1971 on Marine Life*, 1973, 1975, and 1977 (1), (2), and (3). The data of selected established transects, usually 10 meters long, consists of counts for the density of organisms in each of the 10 square meter quadrats per transect. The sample means and 95% confidence intervals for population means are computed. Statistical analyses, for the .05 level, are applied to test significant differences between population means of comparison sampling dates. These involve indicator species as well as all transect species counted for individual transects and/or groups of transects.

The statistical comparison was applied to pre-oil transect data prior to October 31, 1984, and to post-oil transect data after the oil spill from the PUERTO RICAN. Some of the pre-oil transects were established in 1968, but most useful were transect data taken in the 1970's and early 1980's. In the selection of post-oil transects, the key criteria was whether oiled bird feathers, dead oiled birds or oiled debris were found among the transect reefs and beaches.

The following intertidal pre-oil and post-oil transects were selected for study (Figure 1):

Drakes Estero Reef at the mouth of Drakes Estero
oiled feathers

Chimney Rock reefs at the Point Reyes Headland
oiled feathers

McDonald's Beach reef at Tomales Point
oiled feathers, oiled debris

Estero de San Antonio south reef in Bodega Bay
9 oiled dead birds, many oiled feathers, oiled
debris

There were reports that portions of the oil slick came ashore in the above transects. On my days of post-oil sampling on the reef rocks at these transect sites, no oil sheen was visible. My assumption is that since oiled bird parts and debris were on these reefs, there may have been traces then of PUERTO RICAN oil on these intertidal rocks. Certainly, my study transects were not like the oil-covered jetty rocks I had observed and photographed in Bodega Harbor on November 10-12, 1984, the area most inundated with oil.

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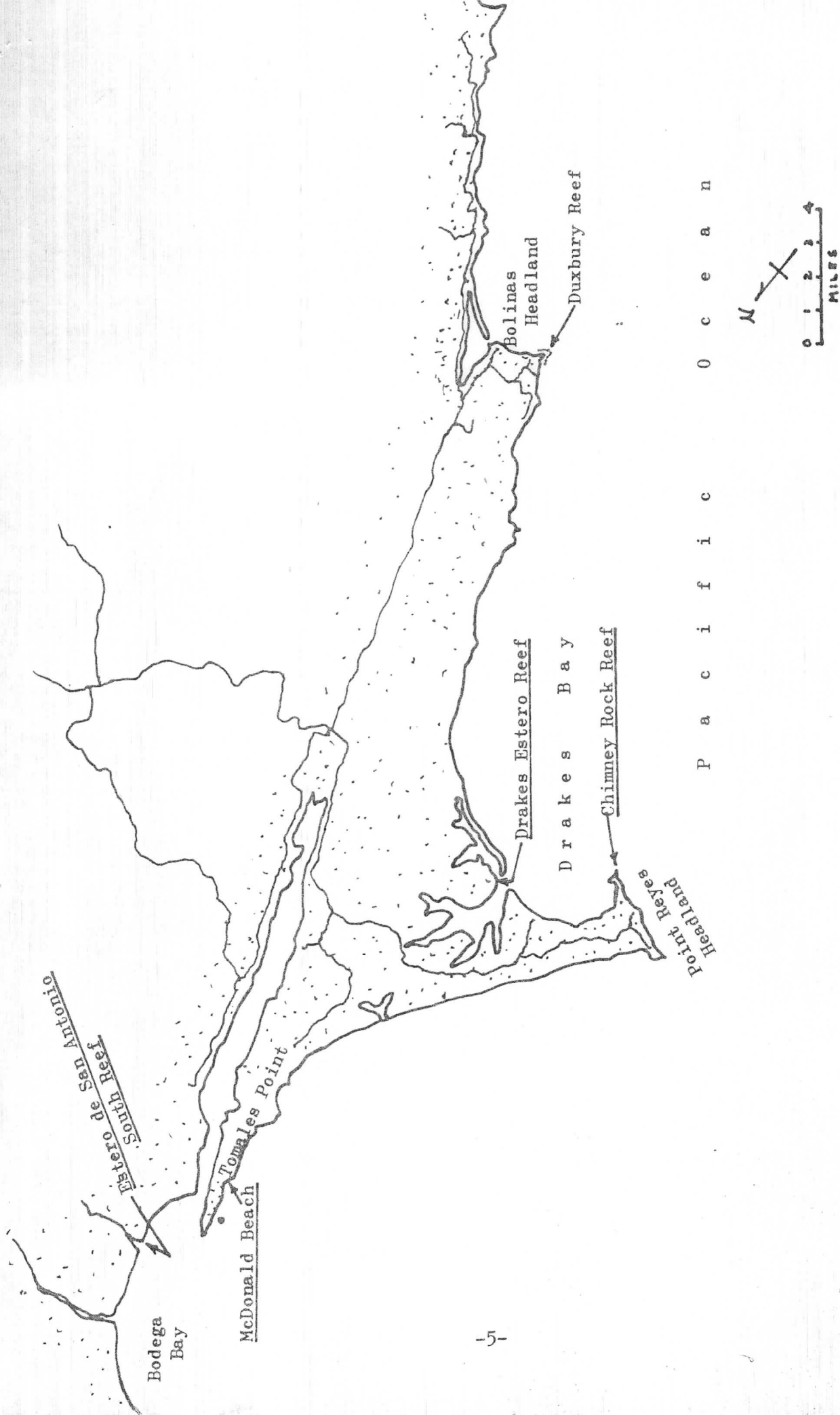


Figure 1. POINT REYES NATIONAL SEASHORE, TRANSECT SAMPLING SITES

The comparative analyses of pre-oil and post-oil reef transect data were made for the following marine invertebrate groupings:

1. Sessile *Anthopleura xanthogrammica*, green sea anemone
 A. elegantissima, aggregating sea anemone
 Mytilus californianus, sea mussel
 Pollicipes polymerus, goose or stalked barnacle
2. Semi-sessile *Katharina tunicata*, black chiton
 Mopalia spp., chitons
 Collisella spp., limpets
 Haliotis spp., abalones
3. Mobile *Pachygrapsus crassipes*, striped shore crab
 Hemigrapsus nudus, purple shore crab
 Tegula spp., turban snails, plus other gastropods
 Pisaster spp., starfish and others
 Strongylocentrotus spp., sea urchins
 Nucella emarginata, whelk

The density of species within the square-meter quadrats on each intertidal transect will vary greatly when mobile and semi-sessile species are counted and included in the analyses; transect stability would be more reliably examined by comparing just the sessile species. Seasonal differences will also be minimized by the analysis of sessile species only.

In summary, the major objective of this paper will be to determine if there are any statistically significant differences between pre-oil and post-oil transect sampling data. The results form the basis of evaluation of any immediate short-term effect of the oil from the PUERTO RICAN tanker, as far as species population density is concerned.

III. DATA AND OBSERVATIONS

The comparison of data for the sessile organisms in the pre-oil and post-oil transects was the key method of evaluating the immediate effect of the PUERTO RICAN oil on the intertidal biota. The three dominant forms of sessile marine invertebrates sampled were the sea anemones, *Anthopleura xanthogrammica* and *A. elegantissima*, and the aggregation of the sea mussel, *Mytilus californianus*, with the stalked barnacle, *Pollicipes polymerus*. These species were sampled at 10-meter sites at McDonald's Beach reef of Tomales Point and at the south reef of Estero de San Antonio in Bodega Bay. The latter site had the most dead oiled birds during our observation days; it, of course, was adjacent to the Bodega Bay Harbor which had the most oil encroachment. For the sessile invertebrates observed at the McDonald's Beach reef transect, Figure 2 illustrates the sample mean and 95% confidence intervals for the three groups: sea anemones, stalked barnacles, and sea mussels. The sea mussels had the highest sample mean for the two pre-oil samples, 90 and 66 per square meter, and the one post-oil sample, 114 per square meter. The 95% confidence intervals for the population means for the samples indicate no significant difference between pre-oil and post-oil population means for each species.

In like manner, the same three groups of sessile animals at the south reef of Estero de San Antonio, Figure 3, also illustrated no significant difference between the population means of pre-oil and post-oil data for each species.

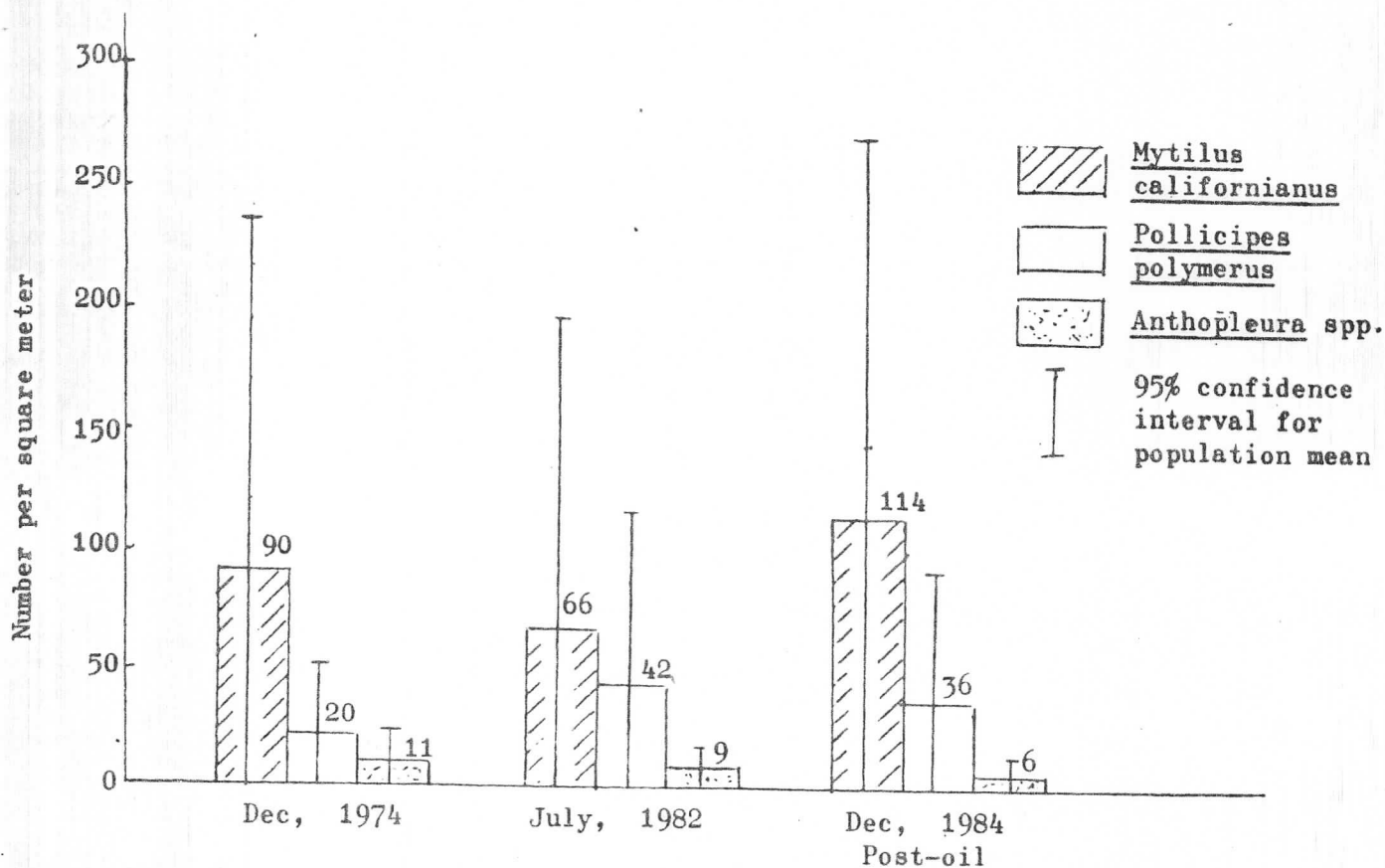


Figure 2. Sessile species for McDonald's Beach transect MB-2a, 10 m.2

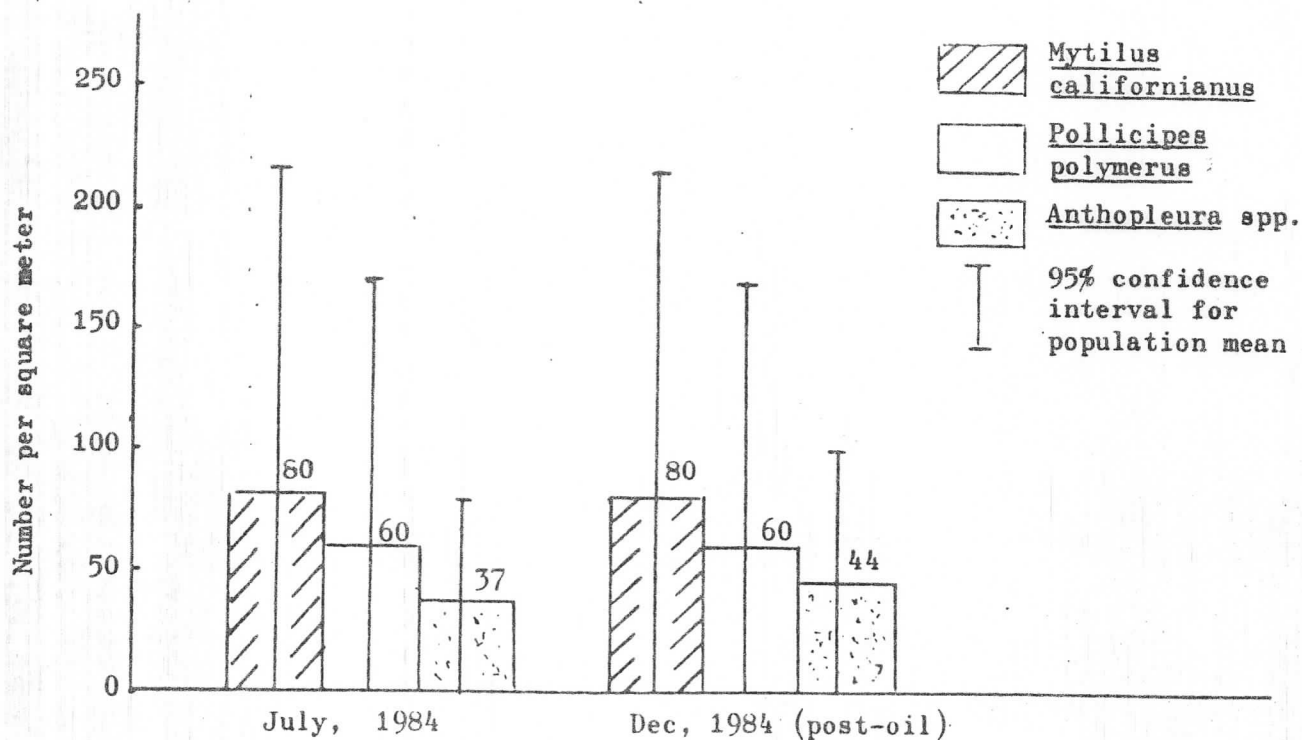


Figure 3. Sessile species for Estero de San Antonio transect ESA-1, 10 m.2

In terms of mobility, species sampled could be viewed as three groups:

Sessile: Mussels, barnacles, sea anemones

Semi-sessile: Chitons, gastropods

Mobile: Crabs, starfish, sea urchins

For all three groups combined, Figure 4 shows the data for all transect species sampled for McDonald's Beach and Estero de San Antonio. There was no significant difference between the population means.

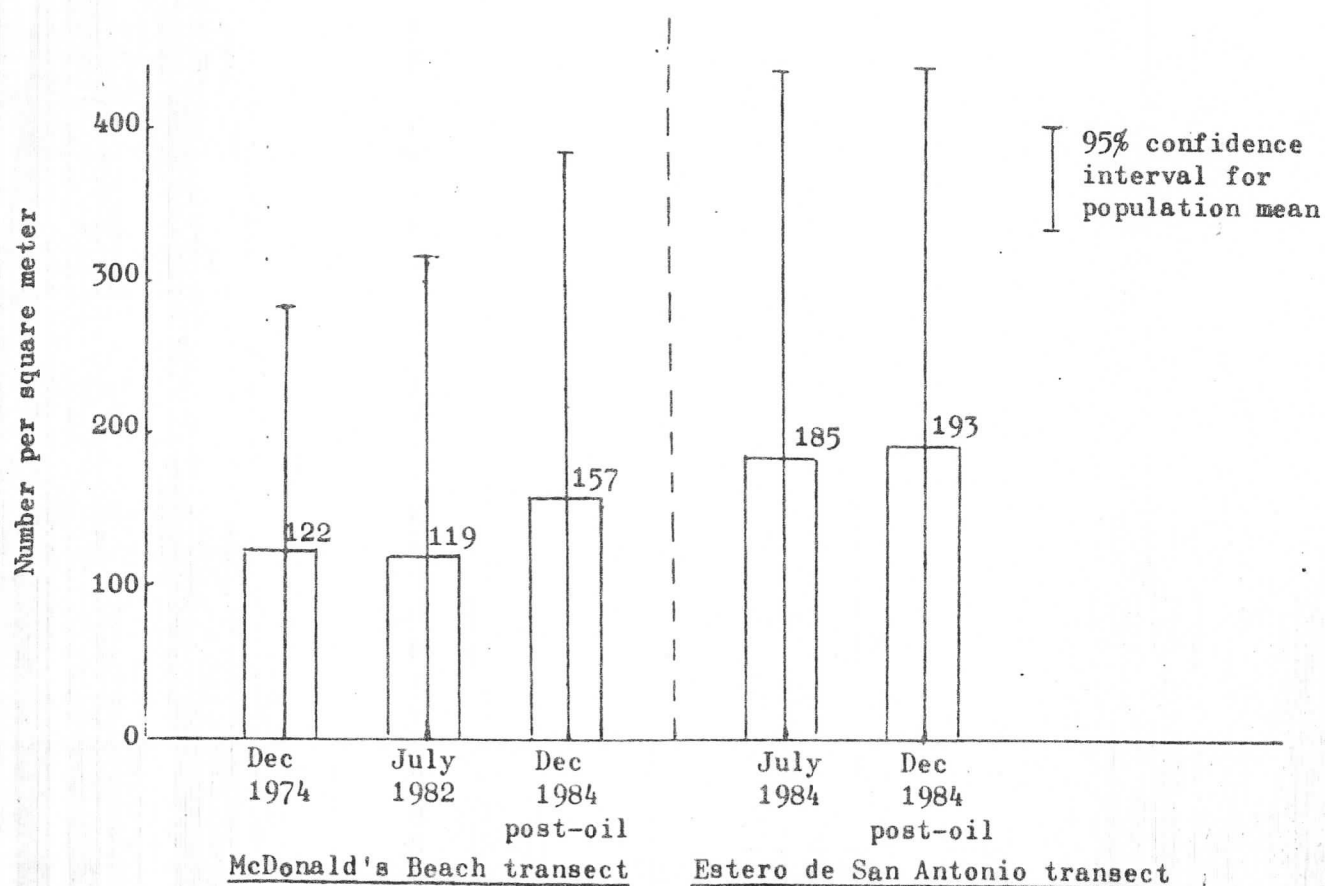


Figure 4. All transect species, McDonald's Beach and Estero de San Antonio

In the Drakes Bay transect sites, the data for reefs at the mouth of Drakes Estero and at Chimney Rock were combined to observe sessile and mobile species. Five pre-oil transect samplings for both areas ranged from December of 1968 through June of 1984. One post-oil sampling is represented by the data for December of 1984, Figure 5. Comparing the 95% confidence interval for population means of all sessile and mobile species, we see that there was no significant difference between pre-oil and post-oil samplings.

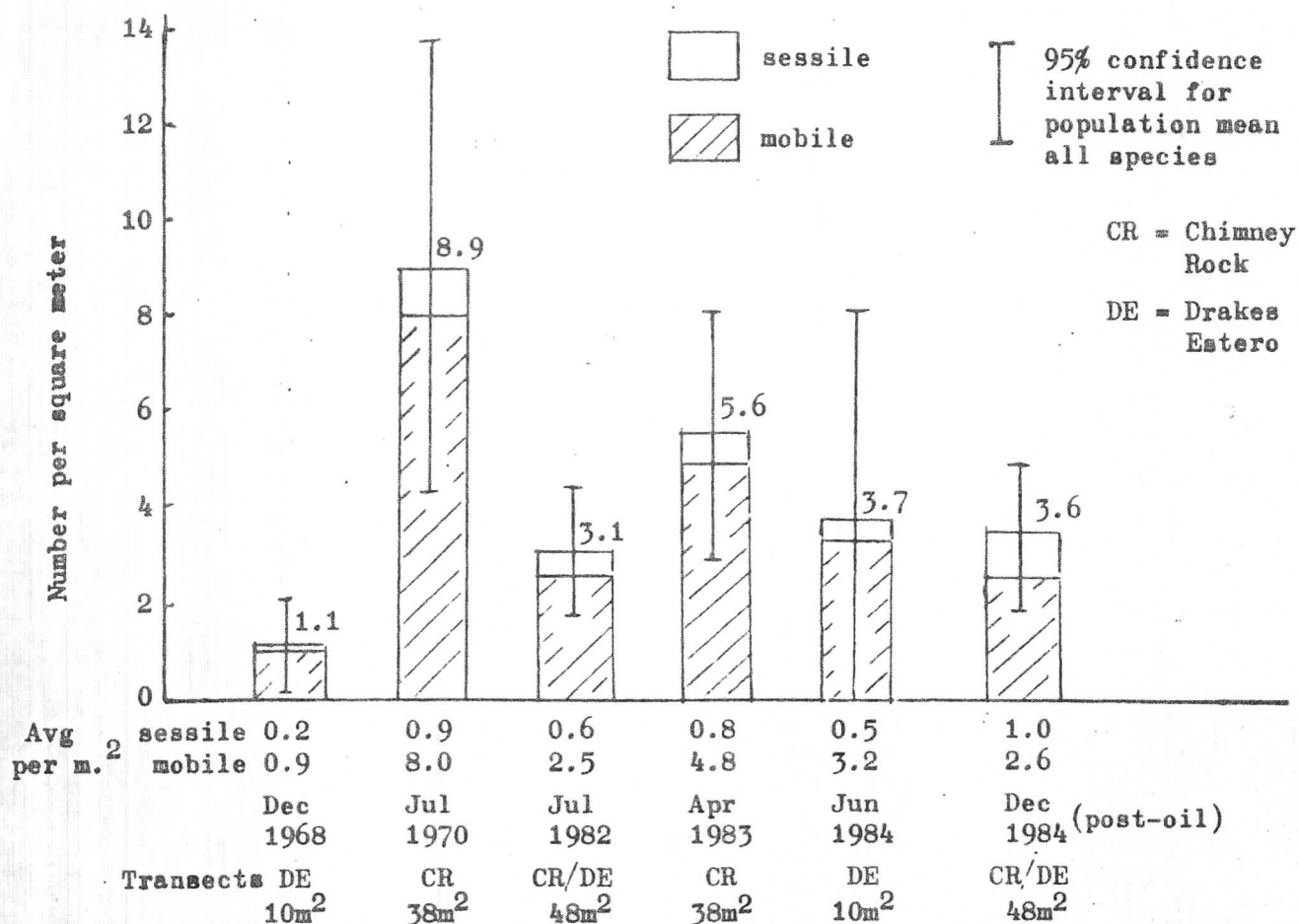


Figure 5. All sessile and mobile species counted for transects at Chimney Rock and Drakes Estero

The comparative study of intertidal abalones at Chimney Rock transect and at McDonald's Beach reef transect at Tomales Point revealed that the total counts for these gastropods remained fairly constant. In fact, the post-oil total count of red abalones, *Haliotis rufescens*, in the McDonald's Beach reef channel showed a slight increase from previous pre-oil surveys, Figure 6. This rise in number is probably due to counting anomalies of the underwater sampling team--that is, counting total numbers of abalones in a subtidal channel area is not as easily accomplished nor as accurate as sampling on quadrat-meter line transects. These total counts are simple reflections of the immediate state of health for this important mollusk fishery.

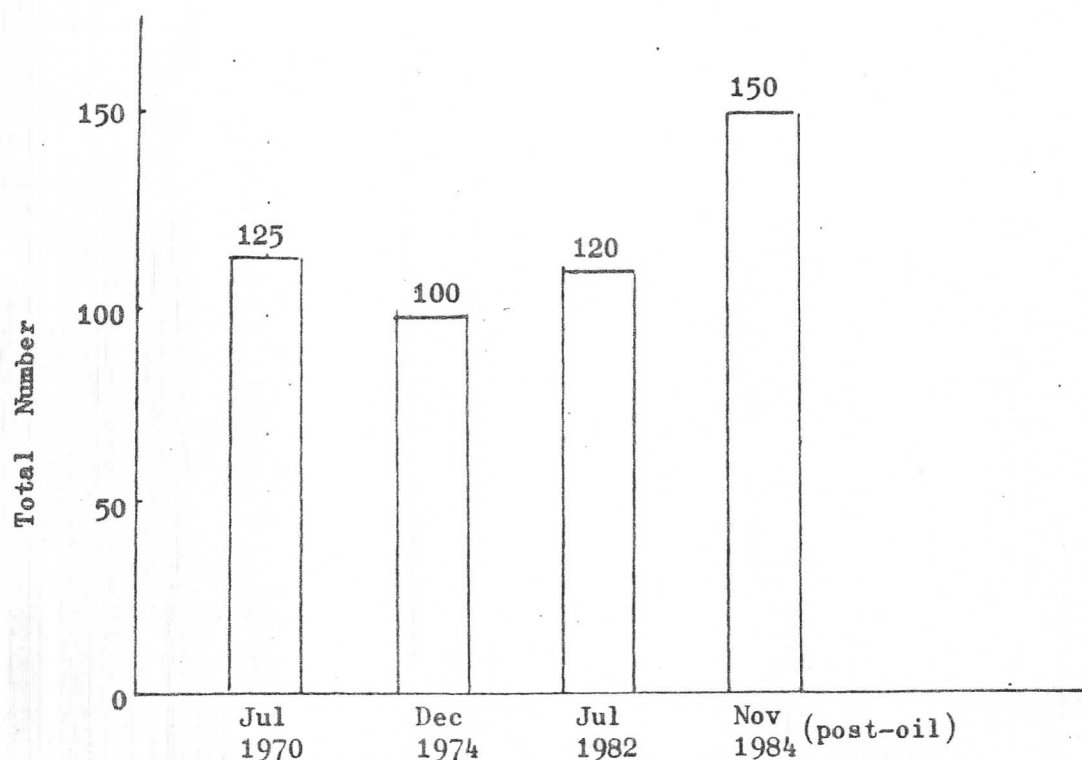


Figure 6. *Haliotis rufescens* total count at McDonald's Beach MB-2c transect, subtidal channel area

SUMMARY OBSERVATIONS

In all of the sites in this study, there are key organisms for each 10 or 20-meter transect:

Drakes Estero reef:

population of limpets

Chimney Rock reef:

population of red and black abalones, owl limpets

McDonald's Beach reef:

populations of sea anemones, mussels, stalked barnacles; subtidal red abalones

Estero de San Antonio reef:

populations of black chitons, mussels, stalked barnacles

In all of these major populations of invertebrates, the test statistics indicated that there were no significant differences between the population means of the various sampling dates. I keyed on the sessile species, then added semi-sessile and mobile species to determine if the latter would produce significant change when all transect species are viewed together. Even with the addition of mobile species, no significant differences among population means were detected for these transect sites. Each transect, with its individual abiotic niche system revealed no statistical differences among its indigenous marine populations between pre-oil and post-oil studies.

To the south of these four transect sites is the massive shale outcropping of Duxbury Reef on the Bolinas Headland (Figure 1). No apparent oil nor oiled debris was found on this reef in my

observation of transects here on November 10, 1984. A survey of key transects indicated a healthy marine population and these complex Duxbury Reef transect populations are abundant. They have formed my major control transects throughout all of my 34 years of observing specific intertidal organisms.

Does the apparent good health of all these marine transects at this time indicate an exercise in futility in regards to the effect of the PUERTO RICAN oil spill? By no means! Even though no oil sheen was apparent on the intertidal rocks of the studied reefs, there were numerous evidences of dead oiled birds and oiled debris--wood, plastic, foam, etc., on these reef ramparts. The multi-dimensional PUERTO RICAN oil can be observed as a light floating, multi-layered system (Appendix A photograph). I had collected this oil on November 12, 1984, among the rocky reefs at Bodega Head. Unfortunately, I do not have any transects on this Bodega Head area, but I did observe the oil sheens on barnacles and mussels of this headland site. I fully believe that the PUERTO RICAN oil did come onto the reefs studied in this report, especially at Tomales Point-McDonald's Beach and Estero de San Antonio where there was oiled debris. In the evaluation of the immediate effect of the oil on my transect sites, there is no apparent damage to the marine intertidal communities.

One last observation might also shed some light on the effects of the PUERTO RICAN oil on marine organisms. On January 7, 1985, while studying transects at Duxbury Reef, Bolinas Headland, I counted 56 of the pelagic red rock crab, *Plueroncodes*

planipes, which has drifted up from its sub-tropical population domain of Baja California. From December 1984 through January of 1985, there have been reports of this pelagic red crab throughout the Gulf of the Farallon waters. In my own observation of this crab on Duxbury Reef, there were 19 female crabs, all with eggs, among the 56 crabs counted (Appendix 1). The reef rocks were splattered with the red guano of sea gulls and other birds. Examining these abundant guano deposits, I could see many red carapace particles in the bird droppings--the reef was "painted" red for the first time in all my years of intertidal studies. During the same time of this rare intrusion of the pelagic red crab, there were Coast Guard reports of continuous seeping of oil from the sunken stern of the PUERTO RICAN. The pelagic red crabs on Duxbury Reef had no traces of oil on their bodies; most were still alive during my low-tide observations.

IV. SUMMARY AND CONCLUSION

From November 3, 1984, oil slicks were released from the sunken stern of the PUERTO RICAN tanker, and portions of these slicks washed ashore at the northern sections of the Point Reyes Peninsula and Bodega Bay area. A comparison was made of the pre-oil and post-oil data for the 10-square meter transects established at the intertidal reefs of Drakes Estero, Chimney Rock-Point Reyes Headland, McDonald's Beach-Tomales Point, and Estero de San Antonio. The comparative sampling of the density of sessile organisms in the 10-meter quadrats was the key method of study. Such sessile organisms were mussels, barnacles, and sea anemones. Additional semi-sessile organisms such as chitons and gastropods were also counted; and finally mobile crabs and echinoderms were also evaluated in the samples. In all of the pre-oil and post-oil transect comparisons, there was no indication of any statistical significant differences between any of the population densities. Even at the vast Duxbury Reef complex at Bolinas, there was no indication of any oil on the reef and the marine populations appeared normal. Therefore, in the immediate evaluation of the marine organisms in all my transects of the Marin County coastline there appears to be no indication of immediate adverse effects at this time from the PUERTO RICAN oil spill.

The only marine site which had significant amounts of visible oil on the rocks were intertidal habitats at Bodega Headlands. Unfortunately, I do not have any population transects

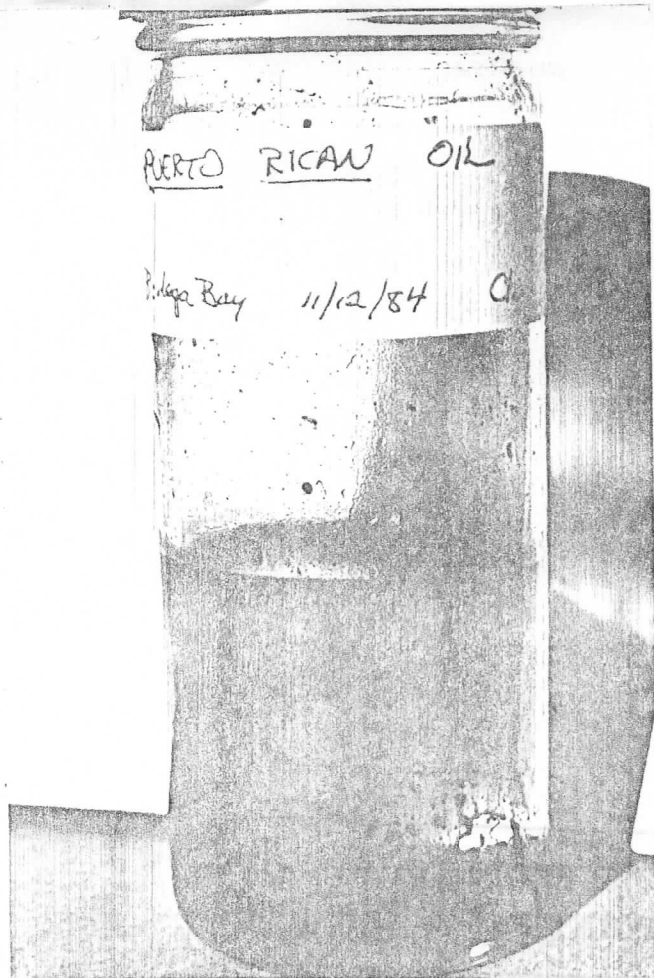
in this area. In my transect study areas of Tomales Point and Estero de San Antonio, there was no visible oil sheen on any of the reef rocks, but there were much oiled debris and dead oiled birds throughout the reef sites. It is my opinion that some streaks of oil did come upon the transect sites, but were not measureable as tidal dilution and wave action eroded away this remnant oil.

The composition of the PUERTO RICAN oil of detergent and lubricating types appeared to belong to the C8 and C14 level, thus classified as "light" oil. However, the toxic effects of this multi-type PUERTO RICAN oil on marine life is yet to be fully evaluated. In the overall short-term evaluation of the biota within my transect sites, I can only state that all appears healthy and normal at the moment. In the 1971 San Francisco oil spill, an estimated 7 million or more marine invertebrates had suffocated and died on my study transect sites (1). It was not until five years later that I was able to measure the long-term recruitment and recovery of marine populations and deem the reef to be in restored normal health (3). Even with the current publication date of this paper, February 1985, oil streaks are still being spotted, oozing from the sunken stern of the PUERTO RICAN. A strange scene now is occurring with the tropical pelagic red crabs which have migrated to the Gulf of the Farallons from the Baja California coast and are probably swimming through these oil slicks. Are they being affected by this multi-dimension PUERTO RICAN oil? From my observation of these red crabs on

Duxbury Reef, they appear to be carrying eggs and to be normal in appearance. Certainly, the marine birds find these crabs tasty as evidenced by their bright red guano dotting the reef. With oil still seeping from the PUERTO RICAN stern, the long-term effects of this oil spill is stil in question. I expect that final evaluation will take a much longer period than my previous five-year evaluation with the 1971 San Francisco oil spill.

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APPENDIX A

PUERTO RICAN oil from Bodega Bay, November 12, 1984. At least 3 layers of oil can be observed suspended in this jar of contaminated sea water.

The pelagic red crab, *Pleuroncodes planipes*, from Duxbury Reef, Marin County.

A female crab with eggs can be observed.

