SHORT COMMUNICATIONS

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CONCENTRATIONS OF SEABIRDS AT OIL-DRILLING RIGS[1]

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Over the past decade, several studies have attempted to correlate abundance and distribution of seabirds over the ocean with various abiotic and biotic factors (Bourne 1972; Nettleship 1972; Briggs et al. 1981, 1987; Hoffman et al. 1981). I made observations in the Bering Sea which suggest that oil-drilling rigs, during the stage of "spudding in" (beginning to drill), and during the drilling process, attract large numbers of foraging seabirds.

METHODS

During shipboard surveys in the Saint George Basin of the East Central Bering Sea, other researchers and I collected data on density and distribution of seabirds. These surveys were designed to determine which abiotic factors (e.g., salinity, temperature, hydrographic features) influenced seabird distribution and density. At time of placement of the first oil-drilling rig, the ARCO Ocean Ranger, in the Bering Sea (53°31.4′, 166°57.2′, Fig. 1), the number of surveys around the rig site was increased to measure its effect on seabirds. Here I summarize data collected during 3 weeks prior to rig placement (6–17 June 1977), and for a month after the "spudding in" (15 July–30 August 1977) (Baird 1977; Metzner 1977; W. Hoffman, unpubl. field notes; U.S. Fish and Wildlife Service, unpubl. field notes).

The cruise paths of the NOAA research vessels, Surveyor, Discoverer, Moana Wave, and Miller Freeman came within 1.0 km of this drilling rig both pre- and postspudding and during the drilling process. The methods of Gould et al. (1982) were used on all cruises with continuous standard transects of 10 min each, counting all birds up to 300 m from the ship. In order to standardize each transect, numbers and species of birds sighted were tallied and then divided by the area surveyed on each transect, to yield densities of birds/km^2.

Sampling periods were spaced throughout the breeding season, from early June through the end of August. I analyzed the results of the surveys in two ways. First, I compared mean bird densities obtained on the same day postspudding: within and beyond 10 km of the Ocean Ranger, within a block of 20′ latitude × 30′ longitude (Table 1). Second, I compared data collected at (within 10 km of) and away (>10 km) from the drilling site before and after spudding in.

Because the distributions of shearwaters (*Puffinus* spp.) are notoriously patchy (Guzman 1981, Guzman and Myres 1982), and because shearwaters forage in such large flocks, their inclusion in any count can skew total bird densities. Shearwater numbers simply overshadow all other counts. Thus I did not include them in the statistical analyses.

RESULTS AND DISCUSSION

Densities of seabirds were higher near the Ocean Ranger and postspudding (Tables 1, 2). After spudding in, a significantly greater density of birds was observed nearer the rig than away from it (Kruskal-Wallis $H = 6.0$, $n = 9$, $P = 0.014$; Table 1). At the site, significantly greater densities were also found postspudding than prespudding ($H = 5.33$, $n = 8$, $P = 0.02$). Prior to spudding in, there was no difference in densities at or away from the rig ($H = 0.017$, $n = 15$, $P = 0.896$). Away from the Ocean Ranger, no significant differences in densities were found pre- or postspudding ($H = 0.5422$, $n = 16$, $P = 0.4615$). Likewise, in a comparison of densities during the same day, 5 weeks after the initial spudding in, at distances within 10 km ("at" the site) and >10 km ("away" from the site), significantly greater densities were found at the Ocean Ranger ($H = 6.9$, $n = 6$, $P = 0.005$; Table 2). When shearwater densities were included in any of these analyses, bird densities near the rig and postspudding were even greater. Densities prerigging and postrigging at the sampling site could not be compared with values from Gould et al. (1982) for the same areas, because (1) their scale is not fine enough, and (2) the data from that report are generated from data presented in this paper and in unpublished manuscripts from which this paper is taken.

I measured bird densities on a coarse scale (1–100 km; sensu Hunt and Schneider 1987). This is the scale of domains, plume-type upwellings, and oceanic frontal zones. This is also the scale at which many patterns in seabird abundance can be distinguished. I hypothesized that at this scale, differences in patterns of seabird density might occur: (1) by chance alone, (2) by natural variation in abundance and distribution of the prey populations at this site due to abrupt changes in salinity, temperature, or features such as upwelling, and (3) by concentrations of prey species at the site because

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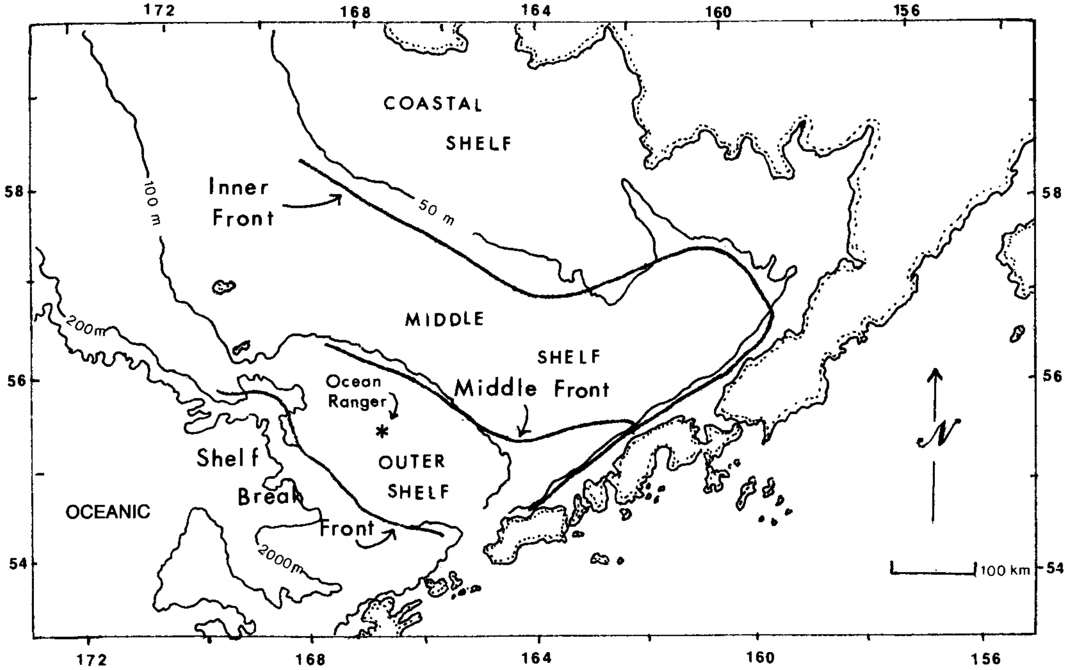

FIGURE 1. Location of drilling rig ARCO Ocean Ranger, with hydrographic domains and fronts of the southeastern Bering Sea shelf (redrawn from Kinder and Schumacher 1981).

of changes in the characteristics of the local waters due to the drilling process or to the presence of the rig itself.

The occurrence of high densities of seabirds at the rig by chance was tested and rejected. Hypotheses 2 and 3 would be difficult to assess if there had only been one cruise past the rig. However, many transects were made in the area of the rig on different dates, and also at near and distant locations during the same day, and over a period of days, and they all showed the same trends in densities: pre- vs. postdrilling and near vs. far.

No known upwellings exist in the area where the Ocean Ranger was placed (Bezrukov 1959, Udinstew et al. 1959, Sharma 1979, Hood and Calder 1981). Its location was in the Middle Front Domain and on the Outer Shelf, about equidistant from the 100- and 200-m isobaths and from the Inner and Shelf Break Fronts (Fig. 1; Hood and Calder 1981, Kinder and Schumacher 1981).

The bottom contours below the Ocean Ranger were not steep, but of the "complex type" for the Bering Sea (Udinstew et al. 1959), on the edge of an area which changed 12 m in depth over a lateral distance of 40 km (Craeger and McManus 1967). This edge runs northwest to southeast over a distance of 700 km, and transects taken both at the rig and away from it crossed over this slope. However, no correlation in seabirds with depth was found during all the surveys ($r^2 = 0.111$, $F = 2.76$, $P > 0.5$).

Since seabirds are opportunistic predators, often partitioning resources on the basis of habitat and not prey type (Ainley 1980), I compared variables of prey habitat such as sea surface and bottom temperatures and salinities both at and away from the Ocean Ranger at the time periods of the transects to see if bird densities might be correlated with these parameters. The Ocean Ranger was not placed at a halocline nor was it near a surface or bottom thermocline (Sharma 1979). The rig was placed almost in the middle of the long-term means of sea surface (8°C) and bottom (4°C) temperatures and salinities (32‰) for this time period (Ingraham 1981). Transects outside the 10-km area away from the Ocean Ranger likewise were not near areas of rapid change in temperature or salinity (Ingraham 1981). Thus it appears that seabird densities away from and near the Ocean Ranger and pre- and postspudding cannot be distinguished on the basis of differences in temperature or salinity.

Hypothesis 2, therefore, that observed differences in seabird density were due to abrupt changes in salinity or temperature does not seem to be the best explanation of seabird distribution at the Ocean Ranger. Since seabird density has often been correlated with prey density (Jesperson 1930, Brown et al. 1979, Obst 1985), it may be assumed that prey resources were somehow concentrated around the Ocean Ranger. Hypothesis 3, that the presence of the drilling rig somehow attracted prey species to the site, seems to be the best explanation of the concentration of seabirds, although this study was unable to provide definitive support of this alternative.

The Ocean Ranger could have acted as an artificial reef, providing habitat diversity for bird prey. The birds,

TABLE 1. Comparison of seabird density at and away from the ARCO Ocean Ranger, pre- and postspudding.

Bird species	<10 km (birds/km²)	>10 but <55 km (birds/km²)
Prespudding		
Northern Fulmar	1.7	1.1
Shearwaters	–	–
Storm-petrels	1.0	0.4
Phalaropes	0.1	–
Cormorants	–	0.1
Jaegers	–	–
Glaucous-winged Gull	0.5	0.1
Kittiwakes	0.7	0.4
Murres	1.7	6.8
Small alcid	0.2	–
Puffins	0.0	–
Total	6.0	8.8
Total without shearwaters	6.0	8.8
Number of cruises	9	11
Postspudding		
Northern Fulmar	11.1	0.3
Shearwaters	178.3	0.4
Storm-petrels	6.7	0.2
Phalaropes	2.1	0.0
Cormorants	–	–
Jaegers	–	0.0
Glaucous-winged Gull	13.3	0.3
Kittiwakes	4.4	0.7
Murres	0.3	0.4
Small alcid	–	0.0
Puffins	0.2	3.6
Total	216.4	6.0
Total without shearwaters	38.1	5.6
Number of cruises	12	12

then, could have been attracted to marine invertebrates and fish which may have concentrated around and under the rig.

Further support for this hypothesis is that a few dark streaks on the surface of the water were seen near the rig during some of the surveys (K. Metzner, pers. comm.; P. Baird, unpubl. field notes). These streaks could have been dense concentrations of prey species around the rig, natural or caused by the drilling, or they could have been inorganic muds, with no food value to the birds (K. Christensen, CONOCO, pers. comm.). They also could have been bottom sediments being stirred up by the drilling process, thus effecting a planktonic bloom and subsequent concentration of certain invertebrate predators (seabird prey), e.g., capelin, and/or crustaceans near the surface, which would appear dark. Others have reported attraction of seabirds to artificial upwellings caused by whales stirring up the bottom sediments (Harrison 1979), although observations at drilling rigs in the North Sea have not reported artificial upwellings (M. T. Myres, pers. comm.). The streaks also might have been petroleum, and thus deleterious to the birds, although the streaks did not have a sheen

TABLE 2. Same-day comparison of seabird density <10 km and >10 km from the ARCO Ocean Ranger.

Bird species	<10 km (birds/km²)	>10 km (birds/km²)
Northern Fulmar	3.4	0.1
Shearwaters	54.8	0.2
Storm-petrels	2.1	0.0
Phalaropes	1.0	0.0
Jaegers	–	0.0
Glaucous-winged Gull	3.8	0.1
Kittiwakes	1.4	0.1
Murres	0.7	0.2
Small alcid	–	0.0
Puffins	0.7	0.0
Total	67.8	0.8
Total without shearwaters	13.0	0.6
Number of cruises	6	12

and did not look like oil. However, nothing definitive can be said about the streaks because no water samples were taken.

In conclusion, since no sharp gradient in bottom topography, in surface or bottom temperature, or in salinity existed during the times of the surveys around the site of the Ocean Ranger, and since many cruises by the rig site detected similar densities in the categories of pre- and postspudding, and at and away from the rig, I believe that hypothesis 3, that the presence of the drilling rig caused the concentration of seabird feeding flocks, seems to be the most plausible explanation for the density of seabirds at the drilling site. Further observations at sites of drilling rigs pre- and postspudding would be helpful to assess if drilling itself may attract temporary local concentrations of seabirds.

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