influence. All the eggs had virtually the same temperature but 6-9°C higher than the initial temperature after the first shade. The higher temperatures reached during the second exposure was still discernible after 30 min. of shading although the differences between the treatments were small.

The results indicate that ore dust covering an egg increased the heat absorbing and reflecting characteristics of brown, light brown and white eggs sufficiently to increase the dorsal mass of the egg to temperatures of 45°C and higher after only 30 min. exposure to direct midsummer sunlight. The rate of temperature increase and the maximum temperature attained after 60 min. exposure were the highest for brown eggs covered in black manganese dust, (54°C), followed by brown iron dust covered eggs (53°C), followed by white manganese covered eggs (48°C) followed by white iron covered eggs (46°C), followed by the brown control (43°C) and white and light brown control (37°C). Longer exposure or higher initial temperatures gave rise to higher ultimate temperatures although a tendency towards equilibrium was evident after 60 min. exposure.

Colour of eggs appear to be important in the present experiment where the eggs used had no natural gloss. However, it is conceivable that the heat absorbing and radiating characteristics of eggs with a high gloss would be changed even more drastically by the non-gloss brought about by ore dust over and above the colour effect.

Despite extensive research on nest and egg temperature (e.g. Drent, 1970) and cooling rates underneath the parent bird (Frost & Siegfried, 1976) and thermoregulation of the egg itself (Simkiss, 1974) the literature is not clear on the maximum temperatures that the developing embryo may tolerate. However, if 45°C is accepted as the mean maximum temperature for a generalized protein (Prosser, 1973) then it would appear that birds with eggs covered with iron or manganese dust cannot afford to leave their eggs unshaded for even 30 min. at a time during midday. White and light brown eggs remained below 39°C even after 60 min.

In the case of the penguins on St. Croix Island this problem is not an obvious one since the birds protect their eggs well from predatory gulls (*Larus dominicanus*) and thus supply the necessary shade. During heat stress however, penguins tend to raise themselves and stand with outstretched wings. Eggs from such birds may often become exposed to direct sunlight and it is suggested that ore dust on these eggs may decrease hatching success due to overheating.

Species that leave their nests for extended periods may even be more vulnerable to the effect of ore dust especially if the nest attentive behaviour of the birds is adapted to care for the more reflective high gloss eggs found in some species that nest in the open and leave their eggs unattended for extended periods.

General Conclusions

From the first experiment we conclude that eggs of birds such as penguins, constantly on the nest may have a decreased hatching success when they are in constant contact with fine windblown ore dust collected in nesting sites between rocks. This adverse effect of ore dust is possibly due to the mechanical blocking of the respiratory surfaces on eggs by fine dust particles.

The second experiment indicated that the covering of eggs with ore dust changes the heat absorbing and reflecting characteristics of eggs to such an extent that the exposure of such eggs to direct sunlight can lead to lethally high temperatures. These experiments suggest that extensive iron and manganese ore dust pollution are likely to have an adverse effect on the hatching success of eggs.

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Man-Made Debris on the Bering Sea Floor

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Proposed oil development in the Bering Sea has led to intensive biological assessment surveys there. A benthic trawl, used to collect bottom invertebrates and fishes in these surveys also brings up any man-made debris in its path. A description of this debris, its distribution, and frequency of occurrence are given for the southeastern Bering Sea in 1975 and 1976.

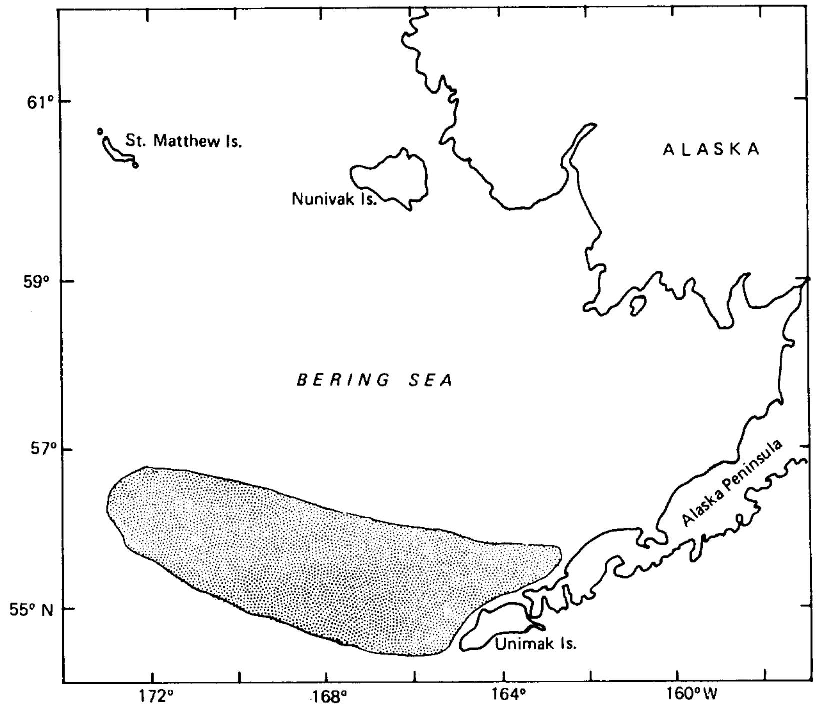

Fig. 1 Study area showing location (shaded area) where 49 debris-containing trawls were made. Debris of Asian origin was found in shaded area west of 170°W Longitude.

Benthic trawls were made from the NOAA ship *Miller Freeman* at stations on a grid extending from 160°W Longitude to 173°W Longitude and 54°30′N Latitude to 60°30′N Latitude (Fig. 1). Each trawl was pulled for 30 min and covered a 12.2 m wide path averaging 3.25 km in length. Man-made debris found in the trawl was classified as metal, rope and twine, glass, plastic, fishing gear, cloth, rubber, wood, or paper product. Most classifications contained a wide variety of objects, for example, metal included wire, cans and metal fragments; fishing gear included derelect crab pots, glass floats, and fish net. No item was placed in more than one classification. Debris was not always recorded in 1975, but was recorded for every trawl in 1976.

In 1975, debris was only recorded for 12 trawls; in 1976, 43 of 106 trawls (41%) contained debris. Occurrence of the various classes of debris was similar in both years except for plastic which was much more prevalent in 1975 (Table 1). Of the 55 trawls containing debris, 49 (90%) were made in the shaded area on Fig. 1. Debris-containing trawls outside this area were widely separated. Debris of obvious Asian origin was found primarily in the shaded area west of 170°W Longitude in Fig. 1.

Most of the debris collected was either metal, rope (usually synthetic), plastic, or glass. In part, this must be due to the longevity of these materials in seawater. We suspect that much of the debris comes from fishing activities since the debris-containing area corresponds closely to the southern Bering Sea fishing areas. The Bering Sea is still relatively less cluttered than the northeastern Gulf of Alaska where Jewett (1976) found 57% of benthic trawls contained man-made debris, primarily plastics.

TABLE 1
Frequency of occurrence of man-made debris on the Bering Sea floor.

Type of debris	Number of trawls in which debris was found		
	1975	1976	1975 and 1976 combined
All types	12	43	55
Metal	2	16	18
Rope and twine	3	11	14
Glass	2	9	11
Plastic	12	7	19
Fishing gear	1	5	6
Cloth	2	5	7
Rubber	1	3	4
Wood	0	3	3
Paper product	0	1	1

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