AN INDEX OF FUR SEAL ENTANGLEMENT IN FLOATING NET FRAGMENTS

Christine A. Ribic*
Center for Quantitative Science in Forestry, Fisheries and Wildlife
University of Washington
Seattle, Washington 98195, U.S.A.

and

Gordon L. Swartzman
Applied Physics Laboratory
University of Washington
Seattle, Washington 98195, U.S.A.

*Present address: Environmental Research Laboratory, U.S. Environmental Protection Agency, 200 SW 35th Street, Corvallis, OR 97333, U.S.A.

ABSTRACT

While information has been published on transect surveys based on visual sighting of floating marine debris, few attempts have been made to link the estimates of floating marine debris density to the entanglement rate observed in subadult male fur seals. Both published and unpublished survey data were used to develop a data base consisting of the location and season during which floating marine debris were observed and the estimated density of the debris. In conjunction with this data base, similar information was used for at-sea sightings of fur seals to calculate an index of potential entanglement by season (winter and breeding season, spring and fall migration). Our main conclusion is that much more information is needed to cover the known range of migrating northern fur seals. However, with these limited data, it appears that seals are most at risk during the breeding season and during the fall migration. Our conclusions are tentative due to assumptions used in calculating the index and the lack of geographical overlap between oceanic debris surveys and fur seal surveys.

INTRODUCTION

The fact of entanglement and the problems it may cause animals is not an area of debate (Center for Environmental Education 1986). But the role of entanglement in contributing to the recent decline of the northern fur seal, *Callorhinus ursinus*, on the Pribilof Islands remains to be clearly

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defined (Fowler 1985, 1987; Scordino 1985). We (Swartzman et al. 1990) have taken a modeling approach to this problem, but the model is only as good as the estimates of the parameters and their inherent variability. In this paper, we calculate an index of potential entanglement by using information on floating marine debris and at-sea locations of fur seals. Problems with this approach are discussed.

METHODS

A review of all papers dealing with floating marine debris was used to gather information on the density of marine debris by area. All estimates from the papers were translated into number of net fragments per square nautical mile for comparison and mapped by area (using blocks of latitude and longitude as defined in the papers). We could not separate the nets into different types (trawl web or gillnet) because the data as presented in the papers were not separated by type. Unpublished data of Yoshida and Baba (Far Seas Fisheries Research Laboratory, pers. commun.) and the 1984 marine mammal observer program data (L. Jones, National Marine Mammal Laboratory, Seattle, WA, pers. commun.) were used to calculate additional density estimates by area. A strip transect density estimate (number of net fragments per square nautical mile) was calculated using a half width of 50 m (Dahlberg and Day 1985) and mapped.

For fur seal occurrence, the data in Kajimura (1980) were used. Those data are presented in summary form in terms of number of degree blocks where 0, 1-4, 5-8, or 9+ seals were seen per hour of observation for all surveys in 1958-74 by month. We calculated an index of high density of seals by 5 degree blocks from these data by month. The index of high density was chosen as the number of degree blocks with five or more seals sighted per hour of observation divided by the total number of degree blocks sampled. We calculated this index for four time periods: January-March, April-June, July-October, and November-December. These periods correspond to winter, spring migration, breeding season, and fall migration (Kajimura 1980), respectively. For each time period, the index of high density was the average of the indices for the months making up the particular period. The indices were mapped for each time period.

The two maps (debris density and fur seal occurrence) were put onto the same scale and superimposed, and areas of overlap identified by time period. Areas of no effort (indicated as blank spots on the maps) for either base set (debris or seals) automatically meant a blank spot for the combined set. For the areas of overlap, an index of potential entanglement was defined as the product of the estimated density of marine debris and the index of high fur seal density. Assumptions made because of the available data include:

- There are no age and sex differences for probability of fur seal occurrence. (Data were not divided into age and/or sex categories.)

- There have been no major changes in the pelagic distribution of fur seals. (Data were collected between 1958 and 1974.)

- Net density is constant over the seasons. (Data were not available on a seasonal basis.)

- The density and location of small and large net fragments are the same. (Data were not presented on a size basis, therefore, differences in probability of entanglement due to differences in size of net fragment cannot be factored into the index.)

- There are no seasonal changes in fragment-specific probability of entanglement. (No information was available on this point.)

The magnitude of the numbers was used to compare the relative probability of potential entanglement between areas within a time period and between time periods.

RESULTS

The papers with the most information on the density of floating nets were those by Jones and Ferrero (1985), Yoshida and Baba (1985), Baba et al. (1988), and Mio and Takehama (1988). Most of the information on floating marine debris has been collected in the North Pacific Ocean in the middle of the fishing fleets (Fig. 1). Most of the information on the presence of fur seals has been collected along the coast and in the Gulf of Alaska (Fig. 2). Fur seals have been seen offshore in the North Pacific Ocean (Kajimura 1980). However, since sighting effort is not recorded, these data cannot be used in a direct evaluation of the probability of entanglement. There are two areas where the maps overlap: around the Pribilof Islands and off the coasts of Washington and Oregon (Fig. 3).

Although there is little overlap between the two maps, for those areas where we could calculate an index of potential entanglement, the highest indices occurred during the breeding season (July-October) around the Pribilof Islands and in the fall migration (November and December) off the coasts of Washington and Oregon (Fig. 3). The index was also relatively high for some blocks off the coasts of Washington and Oregon for the winter season (January-March) and the spring migration (April-June) (Fig. 3).

DISCUSSION

The major problem in estimating the level of entanglement at sea is the lack of systematic observations of both fur seals and marine debris in the same area. The lack of data is so extreme as to present major problems in calculating indices of entanglement while seals are in their pelagic environment. As can be seen from this analysis, there was little overlap between the sets of data for the areas that were surveyed. In addition, for the existing data sets, the units for marine debris density and the probability of fur seal occurrence are not the same. There were no data for the effort behind the fur seal sightings. These circumstances lead to obvious problems in trying to use the existing empirical data to calculate

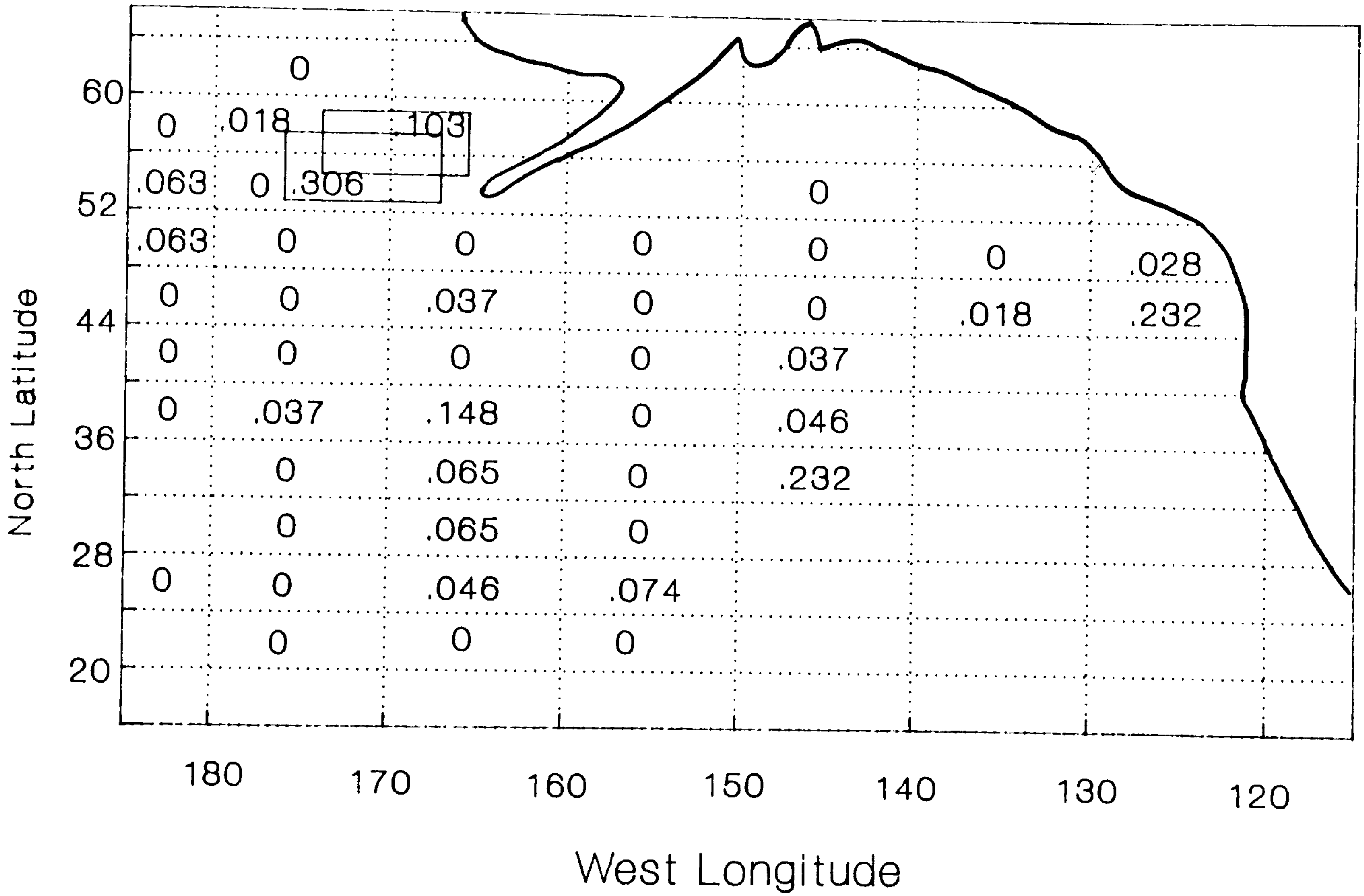

Figure 1.--Density of floating nets by blocks of 4° latitude and 10° longitude calculated from published and unpublished data. The two solid line rectangles indicate areas around the Pribilof Islands where densities were calculated for 2 separate years. The coastline is outlined in black.

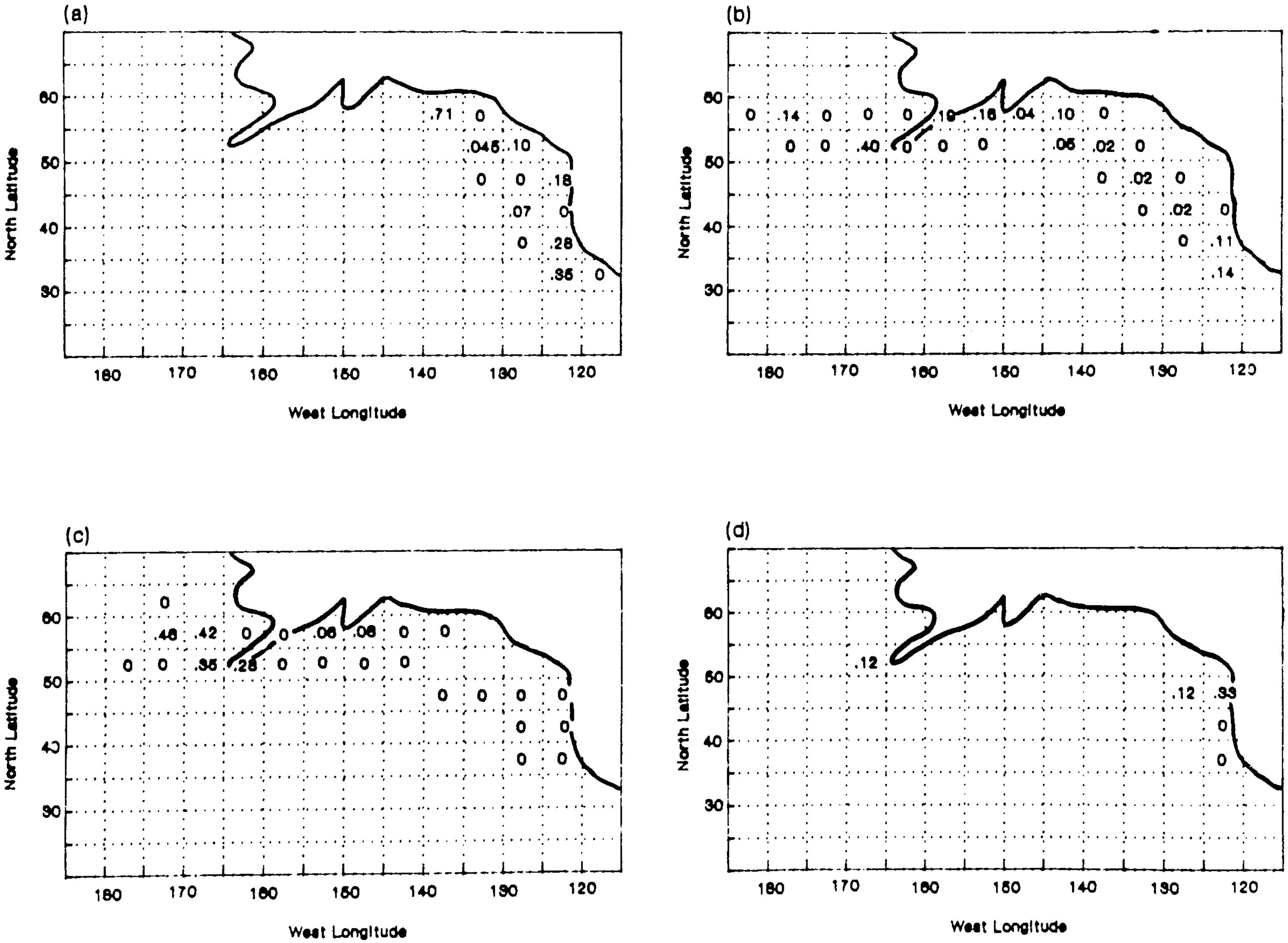

Figure 2.--Index of high fur seal density calculated from data in Kajimura (1980) for four time periods: (a) January-March, (b) April-June, (c) July-October, and (d) November-December. The coastline is outlined in black.

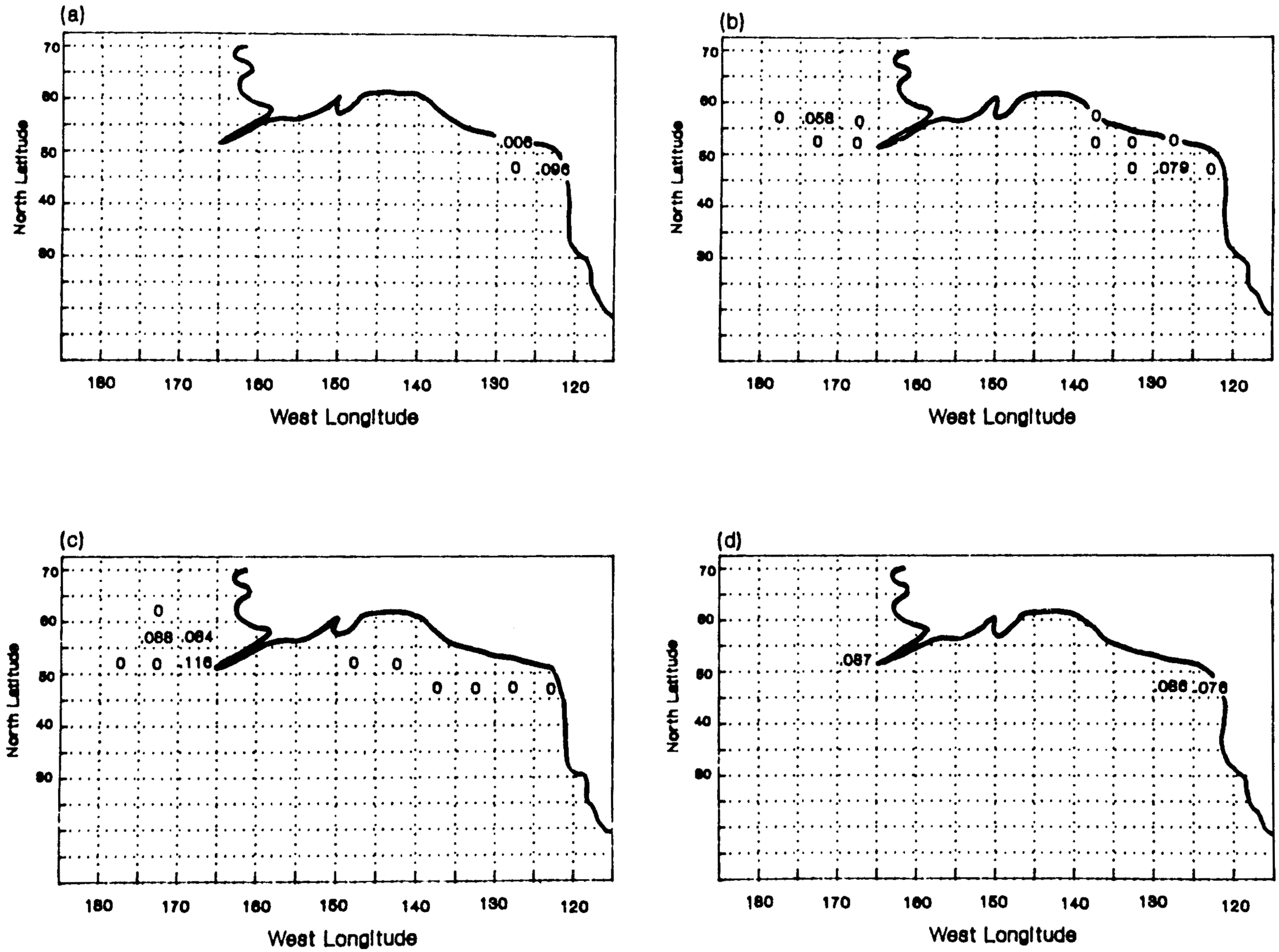

Figure 3.--Index of potential entanglement for common areas between Figures 1 and 2 for four time periods: (a) January-March, (b) April-June, (c) July-October, and (d) November-December. The coastline is outlined in black.

an index. What is needed is a study specifically designed and coordinated for three purposes. The first purpose would be to estimate the density and location of floating net fragments; the second would be to record the numbers and location of fur seals; and the third would be to collect information on the number of fur seals entangled in debris. All three parts of the study should consider the seasonal aspects of the distribution and abundance of both seals and debris. The data from such a study would have the debris and fur seal variables on the same scale (e.g., number per unit area) as well as contain information on the location and date of observed at-sea fur seal entanglement. Until such a study is done, combining results of other studies for such purposes will be highly speculative and will depend on a large number of assumptions, as evidenced by this study.

The assumptions used in this study were made to compensate for the lack of data on variables such as differences in location by age and sex for seals and differences in large and small net fragment densities and location. Changing an assumption will affect the value of the index, but whether the comparisons are changed will depend on how the assumption is changed. For example, if the probability of entanglement upon encounter changes with season, then the comparisons between seasons would be affected.

Given all the assumptions, the index calculated here indicates that the probability of potential entanglement may change depending on the season of year and, in a related fashion, on location. If the relatively high potential entanglement index around the Pribilof Islands found here is valid, then it may indicate that the entanglement problem begins as soon as the young of the year go to sea and continues as the animals migrate south for the winter. Since the first year after weaning is a stressful time for young animals, the actual impact of entanglement may be severe for fur seals going to sea for the first time.

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