# THE EFFECT OF WAVE HEIGHT ON BIRD COUNTS AT SEA

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Although many methods of counting seabirds at sea use transects of fixed width or else determine distance to each sighting (e.g. Heinemann 1981, Griffiths 1982), others use transects with no set width (e.g. Bailey 1966, Shuntov 1972, Brown *et al.* 1975). These are comparable to Powers' (1982) "estimates of density" and "indices of relative abundance". Powers (1982) established that estimates of abundance are at least twice as large as estimates of density for birds sitting on the water but are roughly equivalent for flying birds. While all counting methods for seabirds are affected by a great number of environmental variables (Bailey & Bourne 1972), this note considers only one, wave height, which may have two major effects on estimates of relative abundance. First, the distance to the visible horizon is a function of swell height as well as observer height above the water, assuming other weather conditions are not limiting. More seabirds, especially larger species, should be seen during calm conditions than when the effective horizon is reduced during swells. Second, birds will spend a proportionally longer period hidden behind swells as swell height increases so that more time will be needed to detect each bird.

If the visual horizon v (in metres) = 3 838 h, where h is eye height (in metres) above the sea surface (Bowditch 1966, Heinemann 1981), then the effective visual horizon vs for a swell of s metres can be calculated as vs = 3 838 (h - s). Figure 1 shows the effective horizons for eye heights of 2, 3, 5 and 10 m under swell conditions from 0 to 8 m. An observer with a 10 m eye height would lose 33 % of his or her viewing area in one m swell and 45 % in 2 m swell. An observer with 5 m eye height would lose 45 % of viewing area in one m swell and 63 % in two m swell.

This model assumes that the observer maintains a constant height. A more complicated model for observations from a ship might include length and height of swell. However for an observer at eye height h, in swells of height s, the extremes of observer height will be h + (s/2) and h - (s/2) with a mean height of h so that the original equation presented is a reasonable approximation of reality.

Most transects with fixed observation widths use distances of less than one km. Swells would have to be very large relative to eye height before the effective visibility is less than the transect width. This suggests that transects of fixed width are relatively insensitive to swell height.

In addition to limiting the visible horizon, swells create troughs which conceal birds (Dixon 1977). Techniques which use instantaneous scans of set areas (e.g. Gould *et al.* 1982) to assess bird numbers are likely to miss birds in troughs and behind waves. The higher the swell, the more birds will be hidden at any one time so that instantaneous scans of bird numbers make proportionally greater underestimations of bird numbers with increasing swell height.

Since the effective horizon is sharply diminished in even moderate swell and since detectability of birds, especially small species, falls off sharply with increasing distance (e.g. Dixon 1977) transects without fixed limits or estimated distances to birds are likely to be biased both in species' composition and absolute numbers. In conclusion, fixed widths or estimates of distance and angle to first sighting (Burnham *et al.* 1980) should be features of all methods of counting birds at sea.

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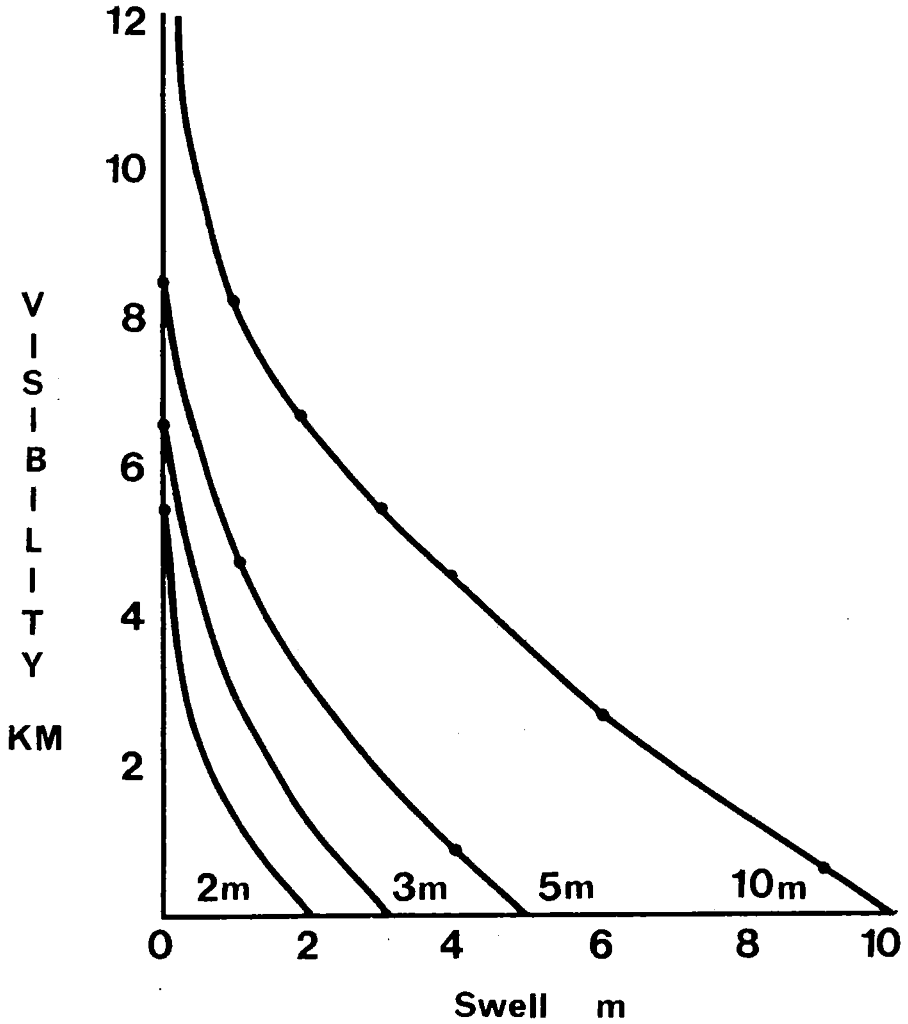


Figure 1

Effective horizon for eye heights of 2, 3, 5 and 10 m under swell conditions from 0 to 8 m.